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The Journal
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Royal United Service Institution.

VOL. XXXVI. JUNE, 1892. No. 172.
[Monthly Issue.]

Friday, April 29, 1892.

LIEUTENANT-GENERAL SIR ROBERT BIDDULPH, K.C.M.G., C.B., Director-General of Military Education, in the Chair.

MILITARY GEOGRAPHY.

By Colonel J. F. MAURICE, C.B., p.s.c., Professor of Military Art and History, Staff College.

THE subject with which the Council of this Society has asked me to deal this afternoon is a large one. I fear a little lest, interesting and important as it is to all soldiers in itself, the mere sketch of its character which our time permits may make it dull for want of illustration. I shall endeavour to avoid that as far as I can, but after all a catalogue of the most interesting books in the world would be dreary reading to those who knew nothing of their contents. The one consolation, therefore, that I have in speaking to you is that I am sure that that is by no means the case. You wish me rather to be in the position of the man who, in merely naming Dickens' works, suggests the pleasures you have derived from the humour of the "Pickwick Papers" and the pathos of "Dombey;" in naming Thackeray brings before you a gallery of familiar faces. You wish me, in fact, rather to express facts familiar to us all than to introduce you to anything that is very new, and must be dreary if it does not receive illustration from your own knowledge and experience.

Military Geography, then, as I understand the term, deals with all those conditions of the surface of the world which affect armies, campaigns, and battles. I do not think that it is possible to separate off from it the minor features of the earth's surface, which we more especially associate with "topography." Our doing so is, I think, an accident of military education. We most of us, in fact, learn to take

in with the eye the features of land under our eyes by actually sketching them. The consequence is that we are very apt, in practice, to talk as if military geography was concerned only with the greater features of a country, its military frontiers, its great mountains and rivers, and so on, and as if the question of the character of a battlefield or the nature of a bridge were pure questions of "topography."

I am not very keen about definitions, and I am by no means sure that, as a matter of mere Greek derivation, this, my assumption, might not be shown to be wrong. What I do care about is the practical question of the effect of any separation of the two things upon the conduct and movement of armies. I had an experience in regard to this very early in my military career which strongly impressed me. Being, I am afraid, in those days, perhaps now, not altogether ready to accept without investigation an established dictum simply because I was told it was the correct thing, I was sorely puzzled by certain explanations which were offered of a particular movement of Napoleon's during the 1814 campaign. I could not understand why he moved as he did. I felt sure he had some very good reason for doing it, but on the ordinary maps the movement, with the details of which I need not trouble you, seemed to be wholly unaccountable. It upset my ideas of the principles on which he acted. The very worthy "crammer," if I may use the term without offence, to whom I went to study military history before going up for the Staff College, would not hear of my objections. Nevertheless, I was not satisfied, and continued my hunt for a cause; when at last, after much research, I, to my infinite joy, discovered, I think in Thiers, a careful description of the nature of the bridges over the Seine, the river towards which Napoleon was then moving. It showed that one particular bridge was a wide massive stone structure, practically indestructible by an army in the field, within the time Napoleon need give to his opponents. The others were slight narrow wooden structures, easily defensible, easily destructible. Instantly the meaning and the motive of Napoleon's disposition of his troops stood revealed. It depended not on some elegant strategic combination such as one might make on a sheet of paper, but upon what I shall venture to call the military geography of the theatre of war.

Perhaps, though it has only an incidental bearing on the subject, I may as well, as I have mentioned my "crammer," say how, from his point of view, the story ended. I sat down, a rather trembling Subaltern, to open my military history paper, with the name upon it, as examiner, of a man long since dead, whom I already knew as a very brilliant soldier, of whom I had the most profound awe. The first two questions that met my eye were: 1st, a request to account for this particular movement of Napoleon's; 2nd, a request for a description of the bridges over the Seine. Instantly I felt that we understood one another. You will, perhaps, forgive me if I thus give point to this particular personal illustration, because I practically have always dated from that moment one of the most valued friendships of my life, and certainly I look upon it as

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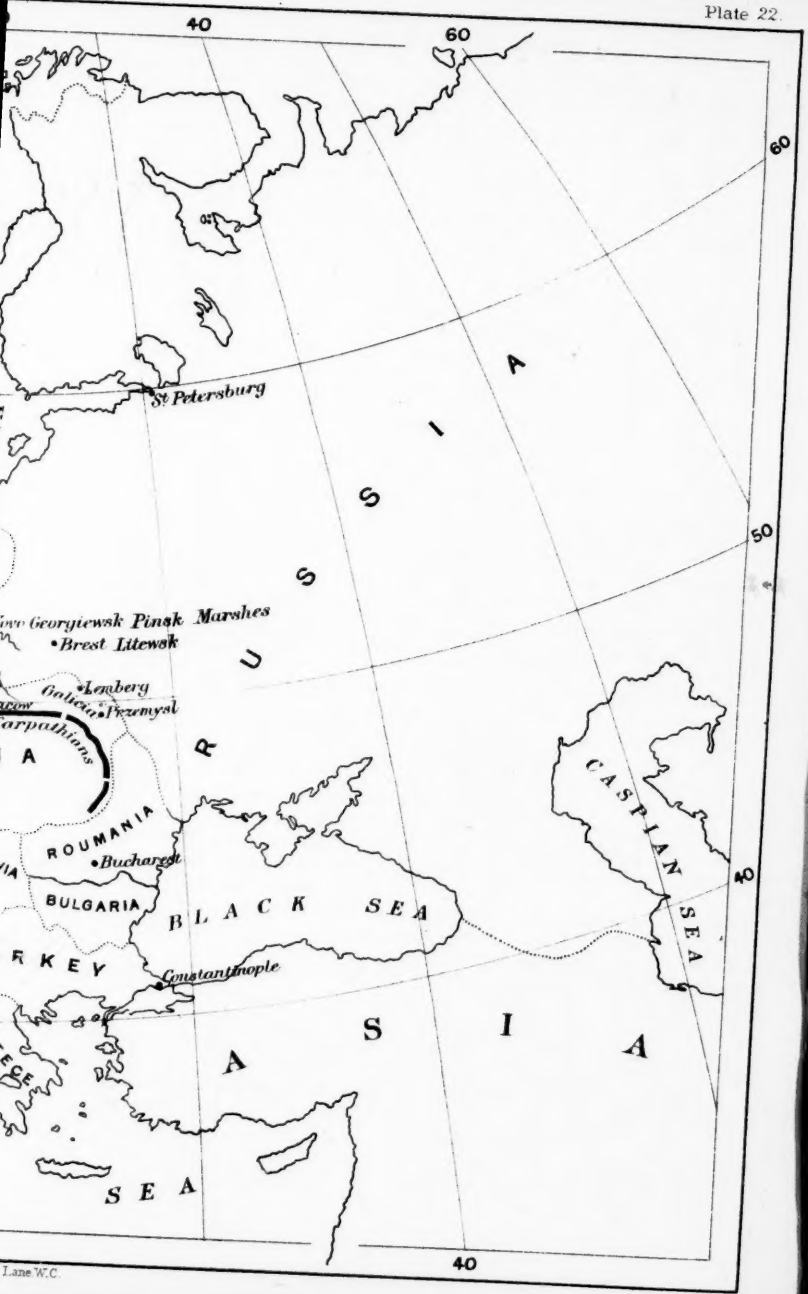
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the starting point of any confidence that I have since then acquired in dealing with the study of military history.

The point, then, that I wish to make is, that military geography, in all its branches, whether it deals with the larger or the smaller features of the earth's surface, is the essential handmaid of military history, past, present, and future. I hardly think that the two subjects can ever be studied with much profit apart from one another. It is, to my mind, a most dreary thing to study, either in the present day or the past, for instance, the military frontiers of the different Powers of the world, unless you connect that study with the historical circumstances which have affected them and been affected by them, and with the opportunities which they present to each of the Powers for either defensive or offensive action. Similarly, I never could myself take much interest in the mere enumeration of the fortresses of a country or description of its main lines of road or other means of movement, except in connection with the history of past campaigns or as part of an analysis of the best mode of attacking or defending it at the present time.

Now, it so happens that all the greatest Continental soldiers of the last twenty years have been at the pains to give all those who care to study their work, practical lessons of this kind in regard to military geography which are quite invaluable. I have often said that if one could have desired to invent, for the purposes of military study, a series of imaginary frontiers with kingdoms behind them, each so varied from the other that in no two should there be a sameness in the lesson, one could not have devised a series so instructive in their variety as the European military frontiers and kingdoms of to-day.

Each of them is based on a well-thought-out principle, in the carrying out of which great military nations, whose whole energy and capacity is concentrated on readiness for war, have each of them expended millions of money. I could not, of course, discuss these this afternoon with sufficient detail to make them intelligible to those who know nothing about them. But consider how varied they are.

France has her great frontier girdle of fortresses; her *forts d'arrêt*, closing every road except at the two gaps which she has designedly left open to admit an enemy, in order that she may there have him at her mercy; her great scheme of entrenched camps giving her both the means of concentrating the powers of the south to strike against an invader moving on Paris and a means of aggression from her old "gap of Belfort," now become sally-port of Belfort. All these are based on the most careful consideration of the geography, and, if I must make the distinction, topography, of the country. Behind them all—Paris the greatest fortress of the world.

Look across the border, what a contrast! Germany now possesses, as her advanced frontier, the old French mountain barrier of the Vosges, and she defends it, how?

Study the condition of her military map, and it will tell you her strategic secrets. But if you are to read them aright, you must not ignore, as questions vital to military geography, the nature of the bridges over her great second military line, the Rhine, nor fail to

watch at the railway stations the vast accumulation of what we in England should call sidings and platforms. She does not require, actually, sidings and platforms as we do, because her carriages give facilities for descent between the rails for men, horses, and guns. But the accumulation of debarking places is enormous.

See, too, on the map, how many minor fortresses have disappeared from it since 1870. Practically all, within the Reichsland, are either dismantled or ignored, except Strasbourg and Metz. Those, indeed, have grown prodigiously—have become enormous entrenched camps. Her meaning is on the surface. Active and rapid accumulation of troops by rail, pivoting on two great fortresses, a river in rear of them, the possession and passage of which she guards by very numerous fortified bridges, both for railways, carriages, and foot passengers. In rear of the great river a few great fortresses, almost all of them fortified camps, placed at her favourite point, the meeting of two great rivers, so that an enemy who attempts to attack them is divided into three separate sections.

Look to the other side of Germany, at her system against Russia.

In principle it is, no doubt, the same, viz., the complete development of the facility of movement by road and railway—specially by railway—a few fortresses, very powerful, and giving command of great bridges, important lines of communication, or the only easy line of march for armies. But how different is the country to which it is applied, and how interesting it is to see how she has dealt with the new geographical considerations! On this side of Europe we are no longer, as in Elsass-Lothringen, or, shall I say, Alsace-Lorraine, in a land of mountains, but in the great plains of the north-east. It is a land of lake and marsh, of dust and mud. Here the one great river, which at different parts of its course is held by Austria, Russia, and Germany, by great fortresses, is the Vistula. It is, in fact, the one grand topographical feature of the country. Thorn and Dantzig, with two other bridge heads, give Germany command of her part of the river. She has developed, as on the other side, her railways, behind and across the Vistula, into East Prussia, and between the lakes which form the southern borderland of that outstretched arm of Germany she has constructed sufficient forts to protect the gathering of her armies and to give her command of the roadway. Her frontier towards Russia, on the western border of Poland, is a land of marsh, guarded by great fortresses, which close the only advance of an army that would not be slow and difficult. To gain time for active strategic movement, to keep an already slower enemy hampered by endless delays: these are the advantages which she seeks to gather from such geographical conditions.

Russia, on her side, presents, as I think, a somewhat deceptive character in what is suggested by the first look at her map. If military geography were represented simply by the outlines of maps, then it would seem as if Russia directly threatened the capital of Germany, which, unlike that of France, is an entirely unguarded town. But there are many conditions properly belonging to military geography which are admirably illustrated by the contrast

which reality presents to this appearance. Russia can only, for the purposes of a direct invasion of Germany across her west Polish border, make use of two lines of railway, one of which runs into the great German fortress of Thorn, beyond the north-west corner of Poland, while the other runs completely away to the southward point of the western border, thus largely fixing for her the possible direction of the advance of her armies. She has not, as Germany has, railways running directly towards the common frontier of Poland and Germany. Further, I should claim that it is a necessary part of the duty of military geography to take account on the surface of the earth, not only of the actual mountains, rivers, railways, fortresses, &c., but of the conditions of the "insect man" upon that surface, in so far as these affect the movements of armies. Under that aspect the condition of the western portion of Russia is peculiarly interesting. The Russian railways have all had their direction determined by autocratic power for strategic purposes. The curious result is that those black lines on the map, which indicate for you the direction in which the railways run, represent in fact two entirely different things on the opposite sides of the frontier. Germany, like Russia, has been anxious to secure facilities of movement for her troops by the organization and working of her railways. But she has done this with a careful solicitude for the needs of commerce, which enables her to work her railways with a large staff, and a reasonable profit to the State. The consequence is that the daily working of the railways kept up by her for the ordinary purpose of commerce and traffic are far more effective means of military transport than those which have been constructed by the Czars solely for the purpose of military advantage, altogether regardless of commerce. I think, perhaps, it would hardly be fitting that I should here, and to you, speak fully of those conditions of the population of Poland and of the neighbouring provinces, which will undoubtedly, in the event of war, very largely affect the movements of the opposing armies. But I want to note in passing that, as such conditions as these must be taken into account in any strategical examination of the theatre of war for the purpose of determining beforehand what operations are to be carried on in it, they are for our purposes an essential part of military geography, though no doubt the scientific people might object that these were properly ethnographical considerations.

The great system of fortresses by which Russia holds Poland presents characteristics essentially determined by the conditions of the military geography of the region, which are entirely unlike those of either France or Germany. There is a certain space of ground held by the fortresses of Ivangorod, Warsaw, and Novo-Georgiewsk, which has always, from the nature of the passages over the rivers which it secures, given to its possessor command of the muddy plains of Poland. The great fortress which stands back from these—Brest Litewsk—is necessary to keep up the connection with the great mass of Russian territory. The enormous marshes which separate Russia from the Polish region present so great a difficulty for the movement

of her troops, that it is essential to have a great fortress at the point where the one railway, across the marsh eastwards into the heart of Russia, meets the various communications which run in towards Poland from the regions to the north and south of the marsh. Behind this frontier region the vast distances, the slender modes of communication which the map of Russia represents determine now, as they have determined in former days, at least in a very important degree, the strength and weakness of Russia.

The geographical characteristics of Austria are again in many respects very distinct from any of these that I have sketched hitherto. It is essentially her geographical position which is at once her danger and her strength. The formidable mountain region of Transylvania, where the Hungarians in 1848 fought so magnificent a series of battles, gives now to the dual Monarchy, as in the days of the Crimea, the complete command of the approach of Russia upon Constantinople. If she stood alone there can be no doubt of the dangers which this powerful weapon of offence would entail upon her. It makes her the chief obstacle to all advance towards Constantinople.

The northern frontier of Austria as towards Russia presents the peculiarity that the border province of Galicia lies between the Vistula and the Carpathians, while a series of rivers of some importance, notably the San, the Wysloka, and the Donajec, run down from the mountains into the Vistula. No country has in former years elaborated a system of fortresses for the possession of a kingdom more complete than that which Austria carried out in Lombardo-Venetia. Along her Galician frontier, on the contrary, it is only of late years that she has taken to constructing very solid works of permanent fortification. It will show, perhaps, the intimate connection between military history and the military map of a country of which I have spoken, if I note that the fact that for many years Austria had relied upon the friendship of Russia, together with the embarrassed state of her own finances, induced her in Galicia to avoid committing herself to the expense of permanent fortifications. When she provoked Russia in 1854, it became necessary to construct vast temporary field works. This had been her resource, in fact, whenever an emergency pressed upon her. Now works of field fortifications, relatively economical and effective for the moment as they are, have the disadvantage that they do not remain effective for very long. Hence practically, during the present period of European politics, when Austria found herself face to face with a bitterly hostile Russia, and when her ally Germany required that she should set her house in order, so that the alliance might be effective without throwing an undue strain upon Germany, Austria found herself with practically the whole work of making a fortified frontier in Galicia to be begun with a clear field. She appears to have fortified the Carpathians with certain works tending to at least delay the movements of an army by the only passes which are available; to have secured the command of the most important part of the Vistula within her region by making a first-class fortress and entrenched camp at Cracow, and by securing as a second pivot

for the movement of her armies powerful works at Przemysl and Lemberg. These works, together with that necessary accompaniment of any modern system of national defence, namely, a great development of her railway system for military purposes, have been the changes in her military map; in the study, that is, of her military geography, which her present political situation has entailed upon Austria. There can be no doubt that the broad outlines of what she designs in view of future war, may in her case, as in others, be traced in what she has done.

Of the opportunities presented to her for offensive war, carried out in alliance with Germany, I have, I think, indicated as much as space will permit me in what I have said already of the frontiers of Russia and Germany. Had she to defend Galicia, there can be little doubt that she would not fall back by the Carpathians, but, employing merely a retaining force within the passes, would take up as successive lines the San, the Wysloka, and the Donajec, threatening a flank attack upon any Russian army that should attempt to cross the Carpathians ignoring the force in Galicia. Thus this frontier presents peculiarities both in its military geography and in the strategical methods which are determined by it, essentially different from any of those we have had to consider elsewhere.

I might enlarge, if time permitted me, upon the contrast presented by the territorial frontier of the fifth great Continental Power—Italy. She, like Germany, to the west has as her land frontier a great mountain barrier. But the snow-clad Alps are a mountain frontier of a very different character from the Vosges. Even here the student of military geography will find a new example worthy of altogether independent study in point of principle from any of the rest. It has been treated, moreover, with that freshness and originality which one might expect from the soldiers of a young country, full of national enthusiasm, and unhampered by the traditions of the past. But the frontier of Italy presents another feature far more interesting to us as Englishmen. Italy possesses a seaboard of such an enormous extent in proportion to her territory, that for her the important frontier is less her great mountain barrier than her coast. All her statesmen and her soldiers, at least as much as her sailors, feel that it is the seaboard of Italy which it is all-important to defend. Hence the relatively great development of the Italian Fleet, hence the anxious desire to maintain those cordial relations with a great naval Power which happily do not depend only upon mere considerations of mutual interest as between England and Italy, but upon those much despised, but all-important, factors of so-called sentiment; upon the hearty sympathy with which from the first England has watched the development of the youngest and oldest nation in Europe, and the complete recognition of that sympathy by Italy.

There can be no doubt that for us, the rise of the Italian Power more than any other event of our times has changed the centre of interest of the military geography of the world for Englishmen. The sea-washed shores of the outer world must always be our closest points of contact with it. The enormous development of our

Colonial Empire, due mainly to our dominion over the sea, naturally caused during many years of the present century the attention of Englishmen, and therefore of English soldiers, to be directed towards our own parts of the world almost to the exclusion of Europe. But two events, of which the rise of Italy is the first, and the approach of a great European Power towards the frontier of India is the second, have changed all that for those who have carefully studied the present signs of the times. I hardly venture, towards the close of my lecture, to touch upon all the problems which are involved in the military geography of our great Asiatic Empire. But I think it will be sufficient to say, first, that Russia is now so near to us in India that we can hardly any longer regard ourselves as having the sea as our sole important frontier, at least as long as we consider, as most Englishmen do, that the defence of the Indian frontier is an essential part of the defence of England; secondly, that she is still so distant from our Indian Empire that it is extremely difficult for us, without great military risk and without handing over to her many of the advantages which the geographical situation at present possesses for us, to forbid her approach in a most dangerous manner step by step towards our frontier. Therefore it is that it becomes exceedingly important to us to inquire whether there may not be geographical conditions in Europe which tend to redress the balance in Asia. I certainly think that there are. The rise of the Italian kingdom with its great seaboard frontier is only one of them. The fact that Italy is an essential constituent of an alliance in which two Powers great as military States, and relatively inferior as naval ones, bear the most important parts, make the means by which alone Italy can be made an effective military member of the alliance as important to them as to her. But even more important to them is the essentially seaboard frontier of Denmark, and the extent to which in all movements of troops between Russia and Germany the whole advantage rests with the Power that commands the Baltic.

The full consideration of all these questions is a matter of the actual study of military geography. They could not be dealt with in a single lecture in which it has been my object rather to take the subject which the Council has assigned me: to show the scope, the variety, and the importance of its interest, and to urge its careful study upon all soldiers, statesmen, or other Englishmen who may have to deal with the problems of the future as they concern our country. For the reasons which I explained in the beginning of this lecture, I have preferred to take the method of illustration rather than that of an abstract setting forth of the principles of the study of military geography. Even for that purpose of illustration, I might have adopted a different method. I might have taken any one or more of our modern campaigns, or of the greater contests in Europe or America, and have shown how a military analysis of the geography of the country was an essential element in determining the conduct of each of them. But on the whole it seemed to me that at the present moment the particular illustrations that I have chosen would be the more interesting, and I can only hope that they will have

fulfilled what I take it was the purpose of the Council, that of drawing attention to the vital importance of this most interesting study.

Dr. MAGUIRE: It appears to me that it would be a pity there should be no discussion following upon such a very interesting lecture; and, accordingly, though a young member of this Institution, I trust you will allow me to say a few words, not by way of criticism, but rather by way of supplement to Colonel Maurice's lecture. I can scarcely imagine any more interesting situations to the theoretical student of history, or to the practical student of the art of war, than those which Colonel Maurice has so ably brought before us. My wonder is that such a large proportion of young English Officers and gentlemen are allowed by their teachers and others to come to somewhat mature age without having some better knowledge of geography, which appears to me to be the basis of the knowledge of history, and, indeed, with so very little knowledge of history itself. I hope, however, that when gentlemen like Colonel Maurice make such remarks as those that appear at the end of his lecture, the attention of the authorities will be forcibly directed to taking steps to secure that English education of the future will not be so defective in these material matters as it now is. I cannot imagine any more interesting way in which a young man even for amusement, not to speak of profit, can spend his time than by taking up a good map and on it following some striking campaign. Unfortunately, one of the maps exhibited to-day is difficult to see from this distance. It is a very valuable map carefully constructed, I believe, by the eminent geographers in the employment of Mr. Stanford, and it shows at a glance the great lines of invasion, not merely that exist now, but that have existed in all ages. I was watching that map the other day when reading some ancient history, and it was astonishing to see that the very routes indicated by Colonel Maurice were the routes taken, as far as tradition teaches us, by the terrible invasions that destroyed the Roman Empire. The map is an exceedingly good one, and if it could be made twenty times larger, it would become invaluable for lectures on military history. Looking at it, one will see that on starting from Russia, as Colonel Maurice indicated, and trying to get to ancient Gaul or Italy, or into the countries around these old objects of barbaric greed, the invading hordes were hampered by the same kind of obstacles that would now hamper invading armies. When they got round the Carpathians to the south or the north, and then had to get down into Italy, they found great rivers and the mighty masses of the Alps blocking their way. Transylvania and the Banat and the Valley of the Drave were to the strategists who had to defend Rome and Byzantium what they now are to Turks and Austrians and modern Italy. The lecturer said he would illustrate these matters from current history, and could equally display them by reference to the past. It would be particularly interesting to see that in past history all the great military movements, backward and forward, surged along the Valley of the Danube towards the Rhine, or, taking a side direction, got involved in the Valley of the Po. For instance, Napoleonic times, taking the campaign of 1796, from the Main to Bohemia, and the Middle Rhine to the Isar, and the Riviera on to the Drave; and again, in 1800, Moreau from the Rhine between the Lake of Constance, and Napoleon across the Alps and across the Po; and, again, the campaign of 1805, when Napoleon started from the Main and the Rhine, and at the same time Massena was moving to the Italian Quadrilateral. In 1809 and 1814 also, it is particularly interesting to see how the operations in the river valleys, eastward and westward respectively, were linked by the gaps in the mountains: for example, by the passes in the Tyrol and by the violation of Switzerland's neutrality. These are suggestions that merely came into my mind whilst listening to the admirable address of Colonel Maurice. Many other suggestions might be given if one had time, but I think I have said enough to show that we are grateful to the Colonel for stirring up memories of the past as well as for his views about the problems of the future. I would further ask the lecturer what he means by stating, with regard to Italy, that the example quoted "has been treated moreover with that freshness of originality which one might expect from the soldiers of a young country full of national enthusiasm and unhampered by

the traditions of the past." I should like to know if Colonel Maurice refers to the most instructive treatise on Strategic Geography by Colonel Sironi.

Colonel MAURICE: I did not refer to any one author. I was thinking of several. It always seems to me one of the most interesting facts we have to do with in connection with the Italian Army that they have entered into these questions unhampered by those traditions of the past which, to a certain extent, tie us all—that the Italians, coming in with a brand new army, naturally deal with these questions with a perfectly unbiassed mind, and that all that has been done in that line seems to have been thought out by themselves and not taken from the mere forms of France, Germany, and Russia, or from things as they are.

The CHAIRMAN: If no one is anxious to ask any further questions of Colonel Maurice I will only venture to say, on my own behalf, how much gratified I have been to hear the lecture. I feel that it is a subject which cannot be too prominently brought to notice. The study of Military Geography is one that has this advantage, that it continues from all ages; the student of Military Geography is not like the man who, having learned the art of using the bow and arrow, finds that he has lost all his previous training when he has to learn the art of making gunpowder. The same considerations which were alluded to by Dr. Maguire prevailed in the invasions of these countries a thousand years ago as they do now. Therefore it is a study which has a continuity about it which is very advantageous to the student. It was not very long ago that a suggestion was made to me in the Department over which I preside at the War Office, that instead of teaching soldiers, or requiring them to learn history and geography at the Army Schools, we should teach them Military History and Military Geography. I felt bound to say that I thought that it would be difficult to study Military History and Military Geography without having some acquaintance with general history and general geography in the first place, and I think we may say that that applies very specially to geography, because Military Geography is really the application of the geography of the country in so far as it concerns the exigencies of campaigning. I am afraid it is a subject which is somewhat neglected not only in the Army, but in all classes. I may refer to what was written for us the other day in the "United Service Magazine" by a gentleman who has had experience in training candidates for the Army, in which he gives several somewhat ludicrous instances of the ideas which some of his pupils had of history and of geography. I think that their failure to understand properly the several points was due more to defects in their general education, than in any training they may have had for the Army; because the mistakes they made would have been as regrettable in a young merchant or a young lawyer as in a young soldier. I need not say more, except to ask you to allow me to offer to Colonel Maurice on your behalf the thanks of the Institution for his interesting lecture.

Wednesday, May 4, 1892.

ADMIRAL H.R.H. THE DUKE OF EDINBURGH, K.G., K.T., G.C.B., &c., &c., A.D.C., Commander-in-Chief, Devonport, in the Chair.

ELECTRICITY AS APPLIED TO TORPEDO AND OTHER NAVAL PURPOSES.

By Lieutenant F. T. HAMILTON, R.N.

IN May, 1885, a lecture on this subject was given at this Institution by Lieutenant, now Commander, Batten, when Sir Cooper Key took the chair. Since that time, although we have not learnt very much that is actually new about electricity, great advances have been made in perfecting the methods of application, and, as a necessary consequence of competition among manufacturers, the material used becomes better and cheaper every day; therefore its use for naval purposes has become more extended. At one time there was a great tendency to elaborate most intricate machines, which were expected to do everything short of talking, but the more practical experience we get the more we see that electricity, for naval purposes, must be applied in such a manner that the instruments and machines used must be simple, and made in such a way that they will stand the exposure and rough usage inseparable from ship work.

In dealing with this subject, there is not time in the limits of a short lecture to go into the whole question, or to go over again any of the ground trodden by Commander Batten, nor, indeed, is it necessary; therefore it is proposed now merely to make a sketch of the principal points on which we have made advances since 1885. And to facilitate comparison, I will take the different branches of the subject as near as possible in the same order as in the 1885 lecture.

Electric Lighting.

Taking, then, electric lighting first. The internal lighting of men-of-war has now become the rule instead of the exception; it is found that it is economical, clean, and convenient, and, except in the case of quite small vessels, where space does not admit of duplicating the dynamos, and the complement does not admit of telling off special men to tend the machinery, it is invariably fitted. A trial was made at one time of using the hull of the ship as a return, and the "Polyphemus," the P. and O. steamer "Massilia," and Brazilian

ironclad "Riachuelo," and other vessels, were so fitted. The advantage of such a manner of fitting is only economy; the disadvantage is an increased risk of an accidental breakdown, for this reason: If you have a complete wire system, a leak on one lead does no harm, and a second leak on the same lead does no harm; it is only when a leak occurs on both leads that harm is done, whereas with the earth return system a single leak at once disables a part of the circuit, thus doubling the chances of a breakdown. The complete wire system is, therefore, always used now, an alternative system of candle lighting being always fitted as well in English men-of-war, the reason being, not so much to provide against breakdowns, as with the amount of dynamo machinery now supplied that is an unlikely occurrence, but to provide against the contingency of not being able to light your fires, or of wanting to economize coal. This latter point, viz., economy of coal, is a very important one. In war-time a cruizer will probably require every pound of coal she can carry for steaming purposes, and she will probably use no electric light at all. To give an idea of what this means, practically, a vessel of the "Latona" class would use about 5 tons of coal for keeping her internal lighting going for a week, and the space occupied by this amount of coal would stow candles sufficient to last the ship for nearly six months. I do not mention this as a reason for not lighting ships internally, but rather to show the necessity, in war-time especially, of having the alternative system of candle lighting; or, in other words, as a general rule, electric lighting is a great economy and convenience, and, as such, we are right in employing it; but occasions may arise, especially in war, when the small amount of coal it uses cannot be spared, when no money could represent to us the value of a few extra tons of fuel.

With regard to the fittings for internal lighting, no great change has taken place, but all the smaller changes are working in the direction of making everything as watertight as possible, and the cables instead of being led about the ship in more or less clumsy wooden casings, are now made covered in lead, and are put up without any casing, the lead being considered to be ample protection.

With regard to the search light, its use has largely developed, many more being now carried; there is, however, still a great difference of opinion as to the best way of using it. Some prefer a large number of small lights (one war vessel having as many as 13), others prefer a smaller number of lights of high candle power; of course the more powerful light penetrates farthest, but it is open to the same objection as the market basket that contains all the eggs. On the other hand, a large number of lights must be confusing to those using them, and tend to make the ship very conspicuous. Another point connected with the search light that gives rise to great controversy is, whether it should be high or low; if high, the surface of water that is covered by the concentrated beam is very small, and consequently there is a difficulty in picking up an object; if low, some say that the rays striking the water are reflected upwards, and striking on the mist form a screen to objects beyond. There is one point on

which every one is apparently agreed, that the farther you go from the source of the search light, the better you see the objects it illuminates; for this reason, the smallest gunboats are given a powerful electrical apparatus, as they are always likely to be useful as electric light stations for the larger ships. Vessels are also sometimes supplied with portable search light plant, so that it can be landed at a suitable point commanding the anchorage, and well away from the ship herself. Another means by which the observer is enabled to get away from the search light is by using the automatic lamp and controllable projector. By means of an electric motor in the pedestal of the projector, it can be directed both in elevation and training, by merely pressing electric buttons at a distance. There are numerous automatic lamps, that is, lamps in which the consuming carbons are made to feed themselves by utilizing the magnetic force of the same current that causes the light, but unless we have a projector controlled in the manner I have just stated, the automatic lamp is not worth the extra complication it involves, as, if we are obliged to have a man at the projector to train it and elevate it, we may as well let him regulate the carbons by hand. The objection to the controllable projector is its weight and complication. But still the fact that it enables the same person that is observing the approaching torpedo-boat to direct the movements of the projector himself, instead of passing orders to another man (always an uncertain proceeding), perhaps outweighs the objections.

Secondary Batteries.

Having considered the advance made in electric lighting, let us now consider secondary batteries or accumulators, by which we are enabled to store up electricity, and use it again when we require it, the operation of storing only depriving us of about 10 per cent. of the current. These batteries are very convenient for burning electric light, driving electric boats, and for any other purpose for which a powerful and constant current is required. The objections to their use are their weight (as the plates composing them are made of lead), the time they take to charge, and the fact that they require most careful handling, and are easily injured if neglected, or charged or discharged too quickly. The aim of all the manufacturers has been, of course, to diminish these objections as much as possible, but, so far, not with very marked success. To illustrate one of their uses, I have got here a battery of forty of these secondary cells, kindly lent by the Electric Power and Storage Company, for giving us current to work these lights and instruments, and it will be a good example of the direction in which the makers are working if I show you how they have improved their cells. One of the great difficulties has been that if the cells are charged or discharged too rapidly, the positive plates bend and touch the negative plates, and so short-circuit the cell (as it is termed) and spoil it. The plates of the cells are made of lead, with a paste of oxide of lead adhering to the surface. In the earlier plates the lead is formed into a grid, and the oxide

placed in the holes; these lumps of oxide constantly drop out when the plates bend. In the latest form of plate there is more lead, so it is less liable to bend, and the oxide seems to stick in better. This gain in strength enables the cell to be charged and discharged at twice the rate of the earlier pattern, but as there is less oxide compared to the size of the plate, there is less capacity; that is, the cell will not store so much electricity, and also it is heavier in proportion to the work it does. The following table will give an idea of the advance made in the rate of charging and discharging, and the expense in weight and capacity at which it is gained:—

Type.	Size of plate.	Maximum rate of discharge.	Time of discharge.	Capacity.	Weight of 31-plate cell complete.
		ampères	hours	ampère hours	lbs.
L (old)	9 sq. in.	4	9	36	286
K (new)	9 sq. in.	8	3½	28	357

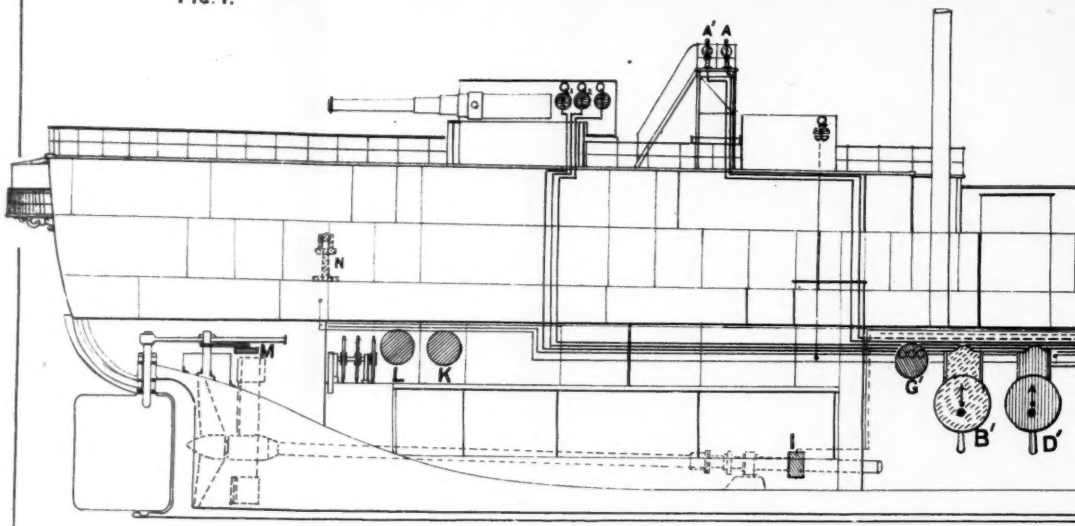
It is not advisable that the rate of charging should be more than 75 per cent. of that of discharging.

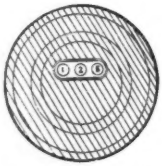
The improvements have therefore given us a stronger and less delicate cell, and one that can be charged and discharged at double the former rate without injury, but we get this at a cost of about 22 per cent. less capacity, and 33 per cent. more weight. The deterioration is now calculated at about 7½ to 15 per cent. per annum. A light and efficient accumulator is a boon we must look forward to yet; with it, steam launches would soon become a thing of the past, and we should be within a measurable distance of the flying machine. Besides the cells I have been describing, a small form is also used for taking the place of primary cells in cases where power is necessary and space is an object, such as in the case of small hand lamps; in the small form, however, the secondary cell is an expensive luxury, as it is even more delicate than the large one, and therefore its life is generally not long.

Whilst on the subject of cells and batteries, I will point out a late development of the primary battery which bids fair to come largely into use, that is, the so-called dry cell. In this the liquid is absorbed by plaster of Paris, or gelatine, or some doughy substance, so that there is nothing to upset. Hellesen's cells, which are an example of this type, were used in the small electric boat on the lake at the Naval Exhibition, for working a small magnet in the boat; they remained in use the whole time the Exhibition was open, which proves that they have great lasting power. They are excellent for ringing bells and such like work, and promise well even for batteries, for firing detonators and charges, under some circumstances.

The subject which next claims our attention is

FIG. I.

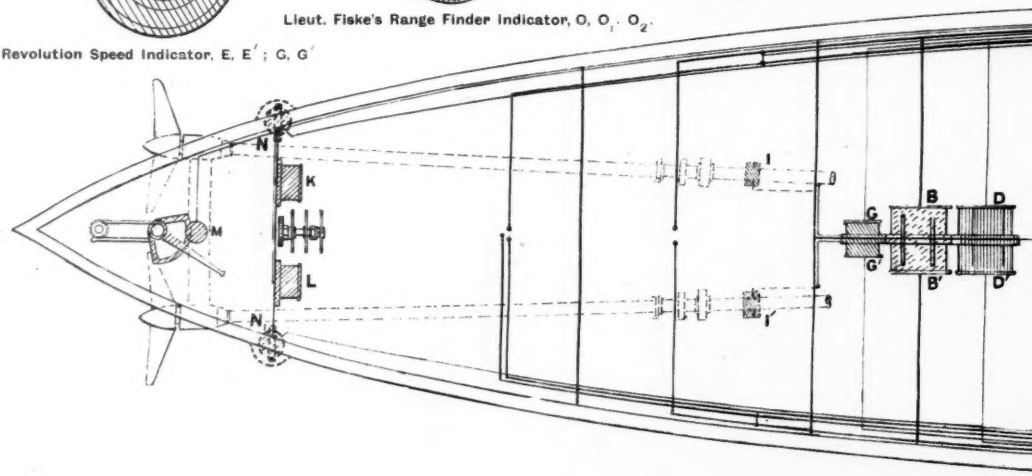




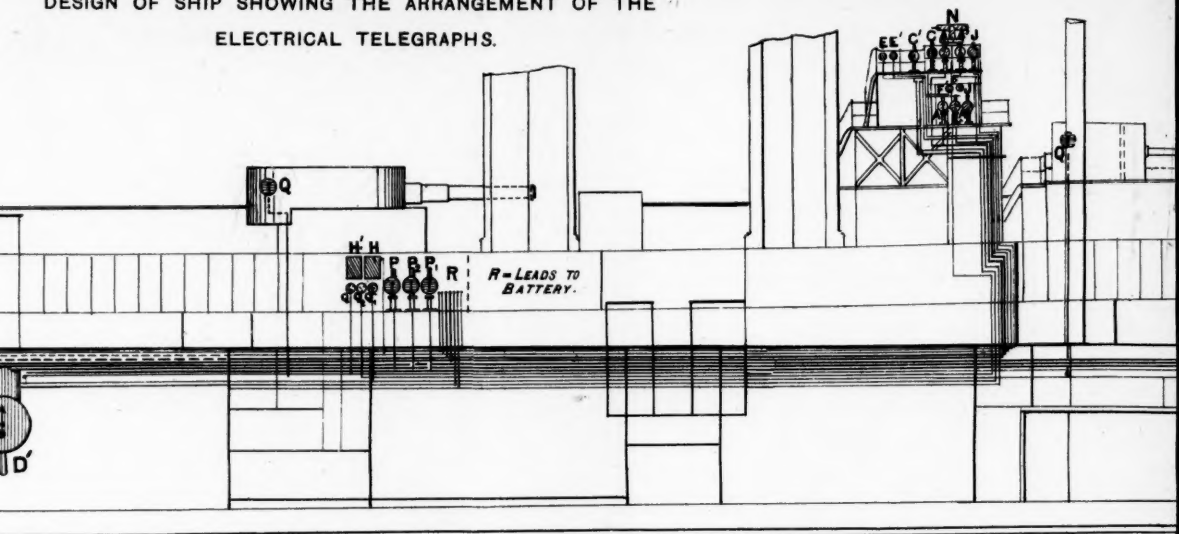
Revolution Speed Indicator, E, E'; G, G'

Lieut. Fiske's Range Finder Indicator, O, O_1, O_2.

H H Control Boxes for Revolution Indicators
I I Contacts on Shafts for Revolution Indica
M Helm Indicator.
N Range Finding Instruments.



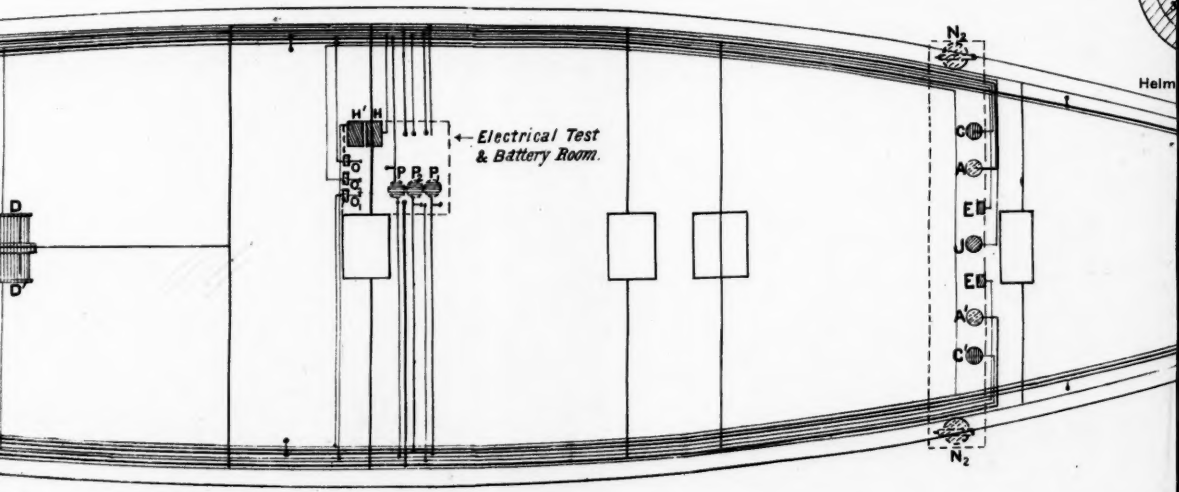
DESIGN OF SHIP SHOWING THE ARRANGEMENT OF THE ELECTRICAL TELEGRAPHS.



cators.
Indicators.

Fiske's Range Finder.
Range Telegraphs.
Engine Room Telegraphs.

Revolution Telegraphs.
Revolution Speed Indicators.
Helm Telegraphs.



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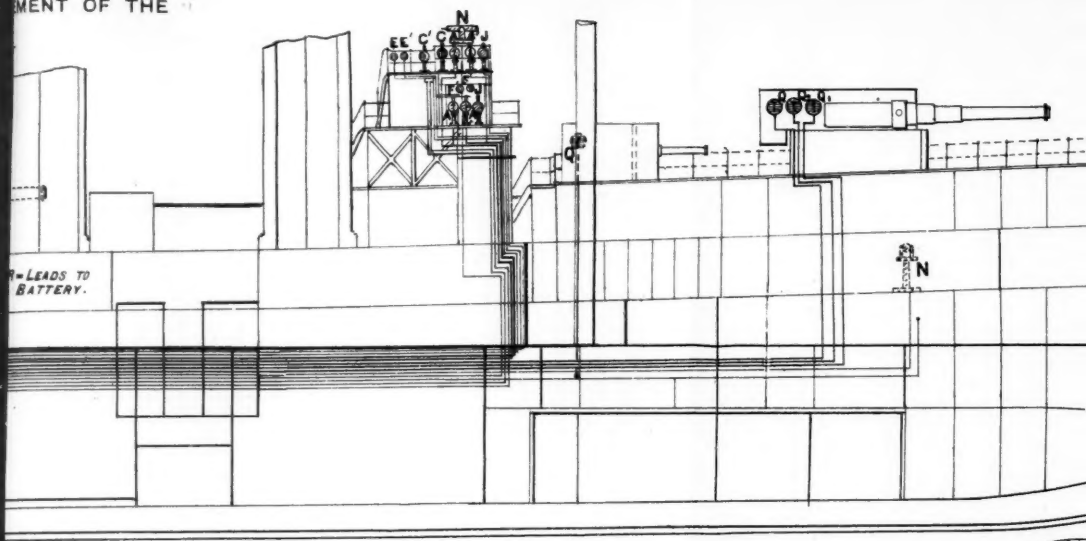
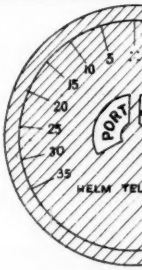
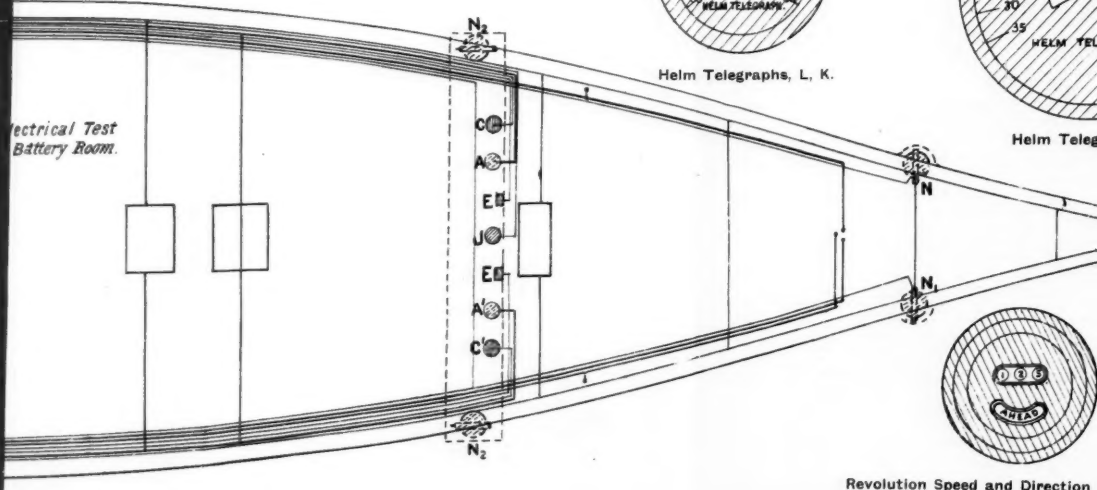


Revolution Telegraphs.
Revolution Speed Indicators.
Helm Telegraphs.

Helm Telegraphs, L. K.



Helm Teleg



Revolution Speed and Direction

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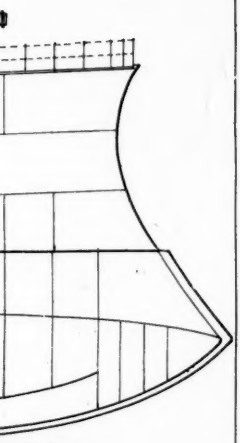
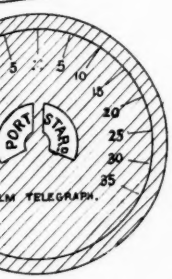
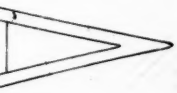


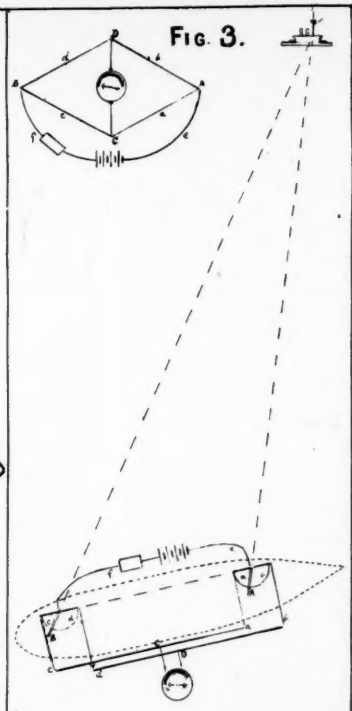


Telegraphs, J.



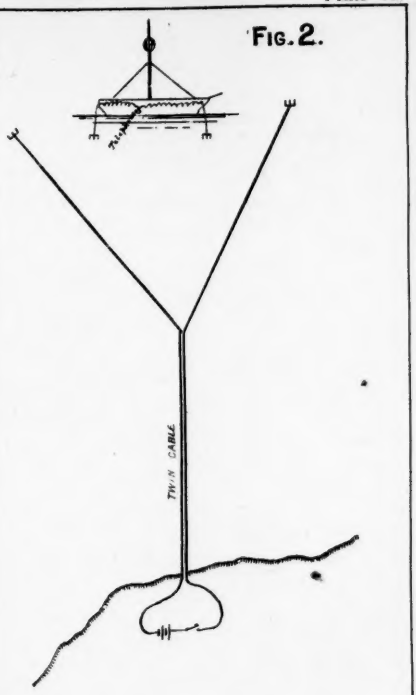
ection Indicator, F, F′

FIG. 3.

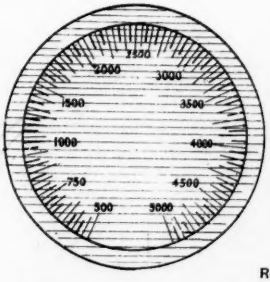


Fiske's Range Finder

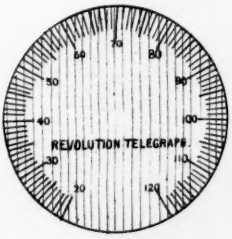
FIG. 2.



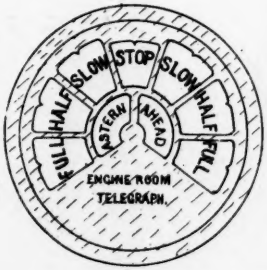
System for communicating with Light Ships and Light Houses.



Range Telegraph Indicator or Transmitter,
P, P_1, P_2; Q, Q_1, Q_2



Revolution Telegraph, C, C′ ; D, D′



Engine Room Telegraph, A, A ; B, B

Electric Communications.

Electricity lends itself to increasing the convenience and rapidity of communications to a very great extent, for signalling beyond the visual distance it is the only method, besides sound, and for short distances where the places between which it is desired to communicate are separated by walls or decks, or bulkheads, it is often the most handy method. In our modern ships of war, for instance, when it is desired to communicate between conning towers or bridges and the engine room, we find armoured bulkheads, watertight bulkheads, and all sorts of obstructions in the way, so if we wish to have one of the old fashioned telegraphs worked by rods we either have to lead the rods in exposed positions where they are liable to be shot away in action, or we have to make holes through watertight bulkheads, thus endangering their efficiency, or make so many angles and gearings that the telegraphs are almost useless on account of the friction and back lash in the working parts. For this purpose then electric telegraphs are peculiarly adapted; distance (within the possible limits of a ship) and angles make no difference, and if the wires connecting the instruments are severed by shot in action, they are easily repaired, whilst the rods of the mechanical telegraph could probably not be repaired without dockyard assistance. Different patterns of these electrical telegraphs have now been in use for some time; the difficulties to be overcome with regard to them are, first, the efficiency, under circumstances of sea service, of the batteries or other sources of electricity that work them, and, secondly, that they should indicate accurately at whatever speed the handle is moved, as however careful an Officer of the watch may be he will naturally push the engine room telegraph over with a jerk if he finds that his ship is just going to run into something. To get over the difficulty of the batteries, nearly every known source of electricity has been tried. The current required should be large, as the larger it is the less delicate the instruments need be; naturally, therefore, secondary batteries have been tried, but by reason of their delicacy and the care required in their use they are not altogether a success. Primary batteries, as being more easily repaired or replaced, have been more largely used, but it is difficult to get great power from them. It is also proposed to work telegraphs with the direct current from the dynamo machine; an instrument of this description has been invented by Mr. Richards, a Constructor in the Admiralty. It only takes half the amount of current necessary to light one lamp, and that only intermittently, whilst it is in actual motion; and as in our modern ships we have ample dynamo power, and always have steam to work it when under way, there seems to be no objection to using the dynamo as our source of electricity; this is, however, quite a new departure, and we have not yet got any practical experience of its working.

The machine that is at present most commonly in use is the Willis's, and the latest improvement of it, the Willis and Robinson's

telegraph. This instrument can be worked either by secondary or by primary batteries. The great point in its favour is that it cannot be thrown out of adjustment by being worked too rapidly, as the handle is not in direct connection with the electric mechanism. The fact of putting the handle over winds up, or extends or compresses a spring, which, in its turn, drives some clockwork; this makes the contacts; and no matter how angry or excited the Officer of the watch may be, the clockwork will only cause the contacts to be made at a certain slow and deliberate pace, quite fast enough for all practical purposes, but not so fast as to incur any danger of upsetting the adjustments. Another good point is that should this instrument show the wrong indication through the handle being worked when the battery is disconnected for any purpose, or through any other cause, it will readjust itself, simply by putting the handle hard over.

Instruments of this description are used for engine-room telegraphs, helm telegraphs and indicators, and for distance indicators to telegraph the distance of the enemy or target from the Officer taking the range to the guns. To prevent the possibility of mistakes, it is always advisable, in any instrument of this description, to have an answering dial, so that you can see that the man at the other end has received the correct signal.

A large ironclad now being built at the Forges et Chantiers de la Méditerranée is quite the most perfectly fitted ship, electrically speaking, that has ever been built; she has electricity for everything, and we shall have to refer to her more than once. Among other things she is to be fitted with a most elaborate system of telegraphs for all purposes (see Fig. I). Messrs. Elliott are now preparing the instruments; they consist of engine-room telegraphs, helm telegraphs and indicators, distance indicators and telegraphs, and revolution indicators. These last are very ingenious instruments, invented by Spratt. The fact of pressing a button on the side of the instrument clears off any former record, and starts the clockwork, which goes for fifteen seconds; on the screw shaft is an electrical contact that is made four times in each revolution, at each contact the instrument indicates one; so that, at the completion of the fifteen seconds, the number shown is the number of revolutions the engines are making per minute.

Whilst on the subject of telegraphs, it will not be out of place to consider the question of electric logs. A difficulty has always been, to keep the revolving contact watertight; this has now been got over in Granville's log, by making the log itself one plate of the battery for working the instrument, the iron hull of the ship the other plate, and the sea itself the exciting liquid, so that insulation is not required. It only remains therefore to decide what combination of metal with iron will give us the best result. Zinc gives a high electromotive force, but is not constant, as the sea water acting on the zinc oxidises it and the strength fails, necessitating constant cleaning. Plumbago gives the best results altogether, as it makes a cell strong enough to work one dial, and does not oxidise at all. If it is desired to use

more than one indicator, the difficulty is easily got over by making the small current from the log work a small and delicate relay, through which a powerful battery on board could be made to work as many instruments as you like. A combination of this instrument with a revolution indicator such as I have just described would enable you to read the speed at any minute by only pressing a button and waiting a few seconds until the counter had finished counting.

The telegraph for distant signalling of messages is of course now universal, and it is therefore very likely that in war-time men-of-war may have to use it under circumstances that will make it impossible for the proper operators to attend. This makes it necessary that a small body of seamen should be trained in the use of the instruments. For this purpose there is a school of telegraphy at Portsmouth; and certain ships are supplied with instruments, so that the men may be kept efficient.

Another use of the telegraph that we are hearing a good deal about at present is for communication with outlying lighthouses and lightships. There are two difficulties in the way: first, that of getting the wire on board the lightships that must of necessity swing to the wind or tide, or through the surf that is sure to be continually beating on the rocks round an outlying lighthouse.

Numerous watertight swivel contacts have been tried for the lightships, they are more or less satisfactory for a time, but they constantly break down; and as for the lighthouses, no shore end of cable has yet been made with a sufficiently heavy armouring to stand the action of a heavy surf on rocks for very long. A plan has, however, been patented by the Telegraph Construction and Maintenance Company, by which communication can be made to both lighthouses and lightships without the cable actually going on board them at all. The plan is this. A twin cable is led out from the shore to within about a quarter of a mile of the lighthouse or ship, the cores are then forked out, and end in large earth plates about one-quarter of a mile apart, one on either side of the place we want to telegraph to. Two earth plates are put overboard, one from either end of the lightship, or on either side of the lighthouse (see Fig. II). If now Morse signals are sent along the twin cable from the shore, using an interrupted current produced by a clockwork sounder, they can be distinctly heard in a telephone on board the lightship. This plan is now under trial, and, I am told, is likely to get over the difficulty of communication.

But the second difficulty is not so easily disposed of. At present lighthouses and lightships are supposed to be exempt from attack in war-time; but if we have telegraphs to them, it will be a sore temptation to use them as outlying signal stations for reporting the enemy's movements, and even if our morality is proof against the temptation, what enemy is going to give us credit for such correct behaviour? The result is, we should, as soon as war is declared, have either to remove them or protect them. The impossibility of protecting them is shown when I point out that there are over fifty round the coasts of the British Isles that an enemy might suppose to

be connected by telegraph, and that he would therefore be quite justified in destroying.

The telephone is not of much use in a man-of-war, as even in ordinary circumstances the noise of the engines, and the noises inseparable from having several men living together in a confined space, make it difficult to hear through; and in action it would of course be absolutely useless. It has also been given up by divers, as they prefer a voice tube, but it is of great use for running temporary lines for signalling during shore operations, or for keeping up communication between different parts of a mine-field, whilst laying mines for the defence of an anchorage.

Another way in which electricity helps us in signalling is by using either coloured or flashing electric lights. There is one system in which three lanterns are used, from which you can at will show either a red or white light. Thus if three lights are used together we can get eight combinations, and if two lights are used as well four more combinations may be obtained. These twelve would be quite sufficient for the few important signals that are required to be carried out quickly at night, such as large alterations of course, stopping engines, or starting. The system has also been largely extended, so as to make a complete code, by increasing the number of lanterns and using, in addition, indicator lights to point out the chapters of the signal book to which the number shown refers. In connection with this system, an Officer of the Austrian Navy has introduced an ingenious but somewhat elaborate switch, whereby the operator only has to set the number of the sign on a keyboard, turn the switch, and the proper signal is automatically shown.

Great difficulty has been found to make the flashing system work properly. There are two ways in which the flashes can be produced, first, by veiling the light, and, secondly, by extinguishing it; if a light is extinguished by a switch in the ordinary manner, you will notice that it takes a very long time for the carbon to cool down to blackness, and, being cold, it also takes a long time to warm up again to incandescence; the higher the candle power of the lamp, and, therefore, the thicker the carbon thread, the longer this takes. The result is, either the flashes have to be so slow that it is difficult to take in the signal, or they are all blurred together and it is impossible. Another difficulty is, that when the current carried through a switch is large, as it is in the case of lamps of high candle power, each break of the current causes a spark that in a short time burns up the switch.

Therefore, to get over these difficulties, several attempts have been made to produce the flash by veiling a light that is continuously burning; they have not been satisfactory, as the fact that the mechanism must be always exposed to bad weather and to violent alternations of heat and cold, renders a delicate instrument impossible; whilst, of course, a large and heavy instrument cannot be placed aloft where, for distant signalling, the flashing light is principally required.

We therefore have to fall back again on the extinguishing system

and try to get over the difficulties; this has been done very fairly successfully in the following manner:—So as to allow the carbons to cool quickly, instead of having one thick fibre, we have a number of thin ones; the lamp so made is called a multiple-fibred lamp; and, as a still further development of the same principle, we put each of the small fibres into a small lamp of its own. This improvement gives us two advantages, first, there is better ventilation and, therefore, more rapid cooling of the fibres; and, secondly, we get rid of the risk of one loop catching over another owing to vibration of the lamp. The incandescence is more rapidly obtained by having a resistance inserted in shunt with the key, which allows a small current to be constantly running through the lamp, not powerful enough to give any light, but only sufficient to keep the fibres at a very dull-red heat; this resistance also helps to get rid of the spark at the switch when turning the light off; and this object is further helped by having a condenser placed so that each coating is in connection with one side of the key. A light of this description, placed on the truck of a ship, is very useful for distant signalling, but does not, of course, have quite the range that the search light has when thrown up into the sky, especially when there are heavy clouds about that can be illuminated by the beam; this method, although slow, still remains the best for very distant work.

The next point on our programme is range-finding. Lieutenant Fiske, of the American Navy, has invented a very ingenious plan, by which electricity can be made to assist us in finding the range of a target or enemy's ship at sea.

The principle of the invention is, that we have two telescopes separated by as great a distance as we can conveniently obtain on board ship (see Fig. III). This distance, forming the base line for the calculation, should be as long as possible, so as to obtain accuracy. The telescopes are mounted on horizontal arcs, which are constructed with a thin wire imbedded in insulating material, running round the edge; attached to the telescope is a rubbing contact that touches this wire; the telescope pivots are joined together through a battery, and connections are made between the ends of the arcs so that the two portions of each on either side of the telescopes form the four arms of an electric balance, and between the arms of the balance is placed a galvanometer to indicate by its deflections when and to what extent the balance is disturbed.[1] Now, if these telescopes are moved along the horizontal arc, the resistance that the arc presents to the passage of the electric current is altered, but if the telescopes remain parallel, the resistance in both arcs is altered to the same extent, and the electric balance is undisturbed, and the galvanometer does not move from the zero point, but the telescopes are only parallel when the object to be observed is at an infinite distance. If, now, the object nears us, the telescopes begin to converge, and the nearer the object comes, the more the telescopes converge, and, therefore, the more the balance between the two resistances is disturbed, this causes a deflec-

[1] The lettering on the two diagrams in Fig. III will enable the reader to refer the connections to the graphic diagram of the balance and so make the principle clear.

tion of the galvanometer proportional to the disturbance of balance. If, now, we mark the galvanometer to correspond with the distances due to the different angles of convergence of the telescopes, we have at once a direct-reading range-finder. This description is not scientifically accurate, as it omits two errors which are so regulated as to eliminate one another, but it is sufficiently accurate to show the principle. This instrument is said to give great satisfaction on board the American cruiser "Baltimore," to which it has been fitted; it has also been fitted up on board the ironclad building in France, to which I referred above, in which ship there are three pairs of instruments, viz., one pair on each broadside in small sponsons about 300 feet apart, and one pair on the fore-bridge, with a base between them of between 50 and 60 feet, for taking ranges right ahead or right astern. These latter instruments are rather differently constructed to the others, as, owing to the short base, they have to be more delicately adjusted, and they do not admit of a training of more than 5 or 6 degrees on either bow. The galvanometers for showing the distances are placed in the electric room, a place in the centre of the ship set apart for the testing and management of all the electric circuits in the ship; in which room the ship's electrician and his staff would be stationed in action. They would read off the distances from the galvanometer and instantly telegraph them to the different guns by Willis's distance indicators.

We will now consider the application of electricity to motors. Their use for various purposes has increased very largely of late years, and they are a great convenience, owing to the ease with which the power is conveyed to them (wires being all that is required), and to the portability of the machine itself whilst working. An example of their portability is the electric drilling machine now largely used in the construction of iron ships.

Where power has to be distributed by the agency of steam or hydraulics, somewhat elaborate fittings in the way of pipes have to be placed, that are not only cumbersome in themselves, but, and this is a serious objection in a modern iron ship, they necessitate piercing the watertight bulkheads; whereas, if electricity is used, the wires can be led through the bulkheads in such a manner as to leave their watertightness still intact.

The objections to the use of electricity are, however, very serious. First, there is an enormous loss of power due to the change of form in which that power is applied, *i.e.*, commencing with steam or heat, which is our primary motive power, we change it into electricity through the medium of a dynamo, then back into mechanical work through the medium of the motor. The second objection is that to develop the power of a motor great speed is necessary; therefore gearing is wanted to reduce this speed to whatever our requirements may be, and of course the use of gearing means a further great loss of power. Thus electricity is a very extravagant way of applying force.

For working guns in ships, where we require to apply our power at many different points, steam is, of course, disadvantageous, as the

trouble of leading steam about the ship and keeping the joints always tight, and the inconvenience attached to getting rid of the waste steam, renders its use almost prohibitive, and another method of transmitting power becomes necessary. The means usually adopted are hydraulics, and in point of economy there is no doubt that it is far the best, for one great reason, that it can be applied direct to the work it has to do without the intervention of gearing.

Nevertheless in one or two American ships and in this new ironclad we have already mentioned as building at the Forges et Chantiers electricity has been adopted, I presume on account of the quality I mentioned above, viz., that it lends itself to facilitating the transmission of power through watertight bulkheads without impairing their usefulness, and also to the fact that the wires are so much easier to repair if damaged in action than pipes.

This vessel is armed with four 24-cm. guns mounted *en barbette*, one forward, one aft, and one on each broadside, and also four pairs of 12-cm. Q.F. guns on twin mountings, the ammunition supply being between them. The larger guns are both trained and supplied with ammunition by electricity, whilst the smaller guns have only electrical ammunition supply. For training the 24-cm. guns, two motors are supplied to each, one being spare; the motor revolves a sprocket wheel by means of a worm and wheel; this sprocket wheel gears into an endless pitch chain which encircles the trunk of the mounting, itself an integral part of the revolving platform. This trunk also forms the ammunition lift, and the ammunition is hoisted through it by another endless pitch chain actuated by a smaller motor. The ammunition hoists at the smaller guns are worked in a similar manner. All the motors are therefore well down below, and are, in fact, under the armoured deck, and in most cases, if not all, they are near steam engines, so it is difficult to see what advantage is gained, as the steam itself might have been used, but I believe the electricity is a duplication of power. The electricity in this case is produced by two very large dynamos driven by engines that appear to be of about 40 horse power.

Motors are also used for driving launches and other small boats. Here again we have a most extravagant form of propulsion, more extravagant even than the motors we have just been considering for manipulating guns, as in this case we have to make one more change, *i.e.*, here we change our steam into mechanical work for driving the dynamo, then into electricity, which is again changed into a chemical form when charging the secondary batteries, then again into electricity, and again back to mechanical work through the motor. Each of these changes means a waste of power amounting in the aggregate to nearly half the power originally developed by the steam engine.

Another disadvantage of this form of propulsion is the enormous weight of the secondary cells; so great is this weight, that high speed is an impossibility in an electric boat containing its own accumulators. In fact I think I shall be within the mark if I say that no boat of this description has ever exceeded 9 miles

an hour; the speed is reduced not only by the enormous weight the boat has to carry, but also by the fact that, the motor revolving at a high speed, the propeller has to be of short pitch; consequently the percentage slip is increased, as also is the skin friction of the propeller itself.

Against these disadvantages we have, when we are dealing with vessels for pleasure purposes, absolute luxury and comfort, as there is no heat, or smell, or dirt, and little or no noise, and for war purposes we are enabled to have a boat driven silently, and without a chance of sparks or smoke to betray her advance to the enemy, therefore probably most useful for torpedo work.

It will, perhaps, be of interest if I describe a boat of each of these types recently constructed by the Electric Power and Traction Company at their works on the Thames, near Hampton.

The pleasure vessel is a river yacht 55 feet long over all, and 8 feet 6 inches beam; she carries 3 tons of accumulators and machinery, consisting of 100 accumulators of the B 15 type, having an output of 150 ampère hours; these cells can be fully charged in 5 hours, and at the full speed at which the boat is driven they discharge in 7 hours; this gives a speed of 7 or 8 miles an hour, and develops about 5 horse power. A switch close to the steering wheel is so arranged that you can go full or half speed ahead or astern, the difference in speed being obtained by, in the case of full speed, arranging the cells 50 in series and 2 in parallel; and in the case of half speed, 25 in series and 4 in parallel; the half speed is about 5 knots. The propeller makes between 700 and 800 revolutions a minute, its pitch being 16 inches and diameter 20 inches. All the accumulators and the motor are either in lockers forming seats, or under the bottom boards, so that the whole of the boat is available for accommodation.

The boat that is presumed to be for war purposes is similar to one that was at the Naval Exhibition. She is a clinker built boat like a large gig 40 feet long; she contains $2\frac{1}{2}$ tons of accumulators and machinery, and weighs about 4 tons without warlike fittings; she is to be hoisted up on board a ship. She has 60 cells, which are used all in series at full speed giving an output of 40 ampères for 4 hours, and a speed of 8 miles. Two of these boats have been recently sold by this Company to the Russian Government. For the purpose of comparing these boats with steam launches, it is perhaps fairest to take the 32-foot Naval Service steam cutter. In this boat with a weight of boiler and machinery (with steam up) of $1\frac{3}{4}$ tons, we get a speed of about 10 miles. There are, however, two points of advantage in the electrical boat over the steamboat that we have not yet noticed: first, that in the former we do not require to carry any extra weight, such as coal and fresh water to keep the engines going; and, secondly, that we can stow the weights in the electric boat to better advantage than in the steamboat, as it does not matter where the batteries are placed, so long as they are in the boat; therefore, as they need not be high, we are enabled to build a boat of deeper keel and consequently finer lines. This advantage does not seem to have

been made full use of yet; when it is, perhaps we may get rather better comparative results between the two modes of propulsion.

We must now pass for a few moments to the question of firing guns by electricity. We have been in the habit of using what is termed a "detector," that is, a galvanometer, so that we can see at any time if the circuit is complete. An improvement on this has been recently introduced by which, instead of seeing, we can hear if the circuit is correct by substituting a sounder for the detector. This instrument has been brought out by Messrs. Armstrong.

Whilst on the subject of guns, I may as well also mention night sights, or a plan for illuminating the sights at night so that aiming is made much easier. As an example, I will take those patented by Captain Grenfell, which consist of two very small incandescent lamps, the current for which is obtained from small primary or secondary cells. The lights themselves are screened from the eye, but throw their light on inclined bars which form the sights. A switch is introduced between the battery and the light, with a resistance in it, so that the brilliancy of the light can be regulated to suit different conditions of atmosphere. These sights will probably very much increase the accuracy of night firing.

The last subject we have to deal with is torpedoes, not because it is least important in this connection, as it practically was brought into being by electricity and exists by it; there is, however, not much that is new to be said. I do not mean to say that as great an advance has not been made in this subject as in others; but this advancement is more in the nature of detail, that it would be impossible to go into in a short sketch like this, and there is very little involving new principles.

As regards submarine mines, the only point we need notice is mechanical mines, or those that carry their means of ignition within themselves, and therefore require no cables. They have been brought more into prominence of late, owing to the notion having been started of using them for what is termed "Torpedo Blockade," that is, for dropping in front of an enemy's harbour to blow his ships up should he attempt to come out. I have often heard it said that we never require to bottle up an enemy into his ports, we want him at sea. Although I hope that may be true, I don't think it can be denied that a very short search into history will show us many cases in which we should have been glad to have the power of worrying our enemy in this way; at any rate mines of this description would be very fair substitutes for cruisers watching a narrow channel when the cruisers themselves are not obtainable.

To be efficient they must be provided with an automatic mooring apparatus that will moor the mine at any required depth from the surface without the necessity of previously taking soundings.

With regard to torpedoes proper, that is, mobile charges as distinguished from stationary charges or mines, electricity is still used both as a means of steering torpedoes and also propelling them. For propelling them, as one might expect from what we have seen of the difficulties of electric boats, the source of electricity cannot be con-

tained in the torpedo itself, with any hope of attaining a high speed. We have, therefore, to fall back on the plan of having a cable between the torpedo and the source of power, for conveying the electric current to it. The most successful torpedo of this type is the Sims-Edison, which has been going now for some years; it was fully described in Commander Batten's lecture in 1885, and since then it cannot be said to have improved very much, but its speed and range have increased, and it is so far serviceable that it will undoubtedly be used in war by some nations.

Attempts have been made lately to use it from ships under way, and there is no doubt that, so far as the machinery that it is necessary to carry is concerned, it can perfectly be done. But its proper sphere of usefulness is undoubtedly as an auxiliary to harbour defence. The difficulty with it will, I am afraid, always be the cable, for this reason. Electrical power can be obtained in two ways: we can either have high electromotive force and small current, or low electromotive force and large current. Either combination will give the same result; just as in the use of water, a high pressure and small quantity can be made to do the same work as a low pressure and large quantity. Now, if the electrical current running through the cable to the motor in the torpedo is very large, the cable must be large and heavy; and the torpedo itself, which has to hold the cable that is to be paid out, must also be large, so as to be able to carry the weight. It is a great advantage, therefore, to reduce the current and increase the electromotive force, but we then come face to face with another difficulty, that if we have high electromotive force, we must have extra good insulation on the cable conveying the electricity, as a leak in the insulation will be immediately fatal to the working of the motor.

Therefore we want to hit off a mean that, whilst giving us a small current and therefore light conductor, will not unduly increase the electromotive force beyond what the insulation of a flexible and light cable is able to stand; in the end it will probably be found that the users of this torpedo will have to rest satisfied with a cable that will be efficient for one or two runs of the torpedo only, but will not stand more use than that. This, of course, means extra expense, a small matter in war-time.

Captain EARDLEY-WILMOT, R.N.: Your Royal Highness, ladies and gentlemen, I was quite sure that we should have a very excellent paper from Lieutenant Hamilton on a subject to which I have paid some attention, and what we have heard has quite come up to my expectations. He truly says "the more practical experience we get the more we see that electricity for naval purposes must be applied in such a manner that the instruments and machines used must be simple." One point also which it is desirable to bring out with regard to the internal electric lighting of ships is this, that however pleasant it may be, and no doubt it is, especially in hot climates, there must always be the danger in action of the wires being shot away, and the ship being thrown into darkness at a critical moment. Therefore, although we may, perhaps, rely upon electricity for lighting the ship below the water-line, all the parts above the water-line certainly should have a duplicate system of candles or oil lamps. I could have wished the reader of the paper had given us a few practical illustrations of the uses to which these electrical machines

had been put, and I may, perhaps, be allowed to mention one or two instances where we have used electricity with very useful effect. He alluded to the search lights and signalling. A few years ago, when we were employed in an operation which political circumstances compelled, viz., the blockade of the coast of Greece, in which your Royal Highness commanded, we had a large number of ships distributed over a large area, and they had to be more or less in communication. In the ship I commanded we had a powerful electric light, and I was enabled to keep up communication with my senior Officer at a distance of 20 miles by pointing the search light in the sky, observing it, and allowing it to flash forth again by means of a shutter, as now used, with an ordinary lantern for short distances. Practically we are better off for distant signalling by night than we are by day. There is one thing, of course, to be remembered, that the electric search light is practically useless in foggy or misty weather. The electric light can, however, be used for different purposes, and I will mention one instance where we found it exceedingly useful. When we were in the Red Sea in 1885 we had a powerful electric light on board. An expedition used to start off in the early morning, and had to be supplied with water. At that time every drop of water had to be distilled in steamers and collected in tanks. It was then put into skins and carried by camels. The expeditions used to start off early in the morning, and it was necessary that the skins should be filled during the night. So we arranged a series of lights on shore, composed of small incandescent lamps, which were worked from the ships' dynamos, through a cable laid to the shore. By that means the whole of the tanks were lit up, and the proceedings were carried on with great expedition and efficiency. The next thing was to place the skins on the camels' backs. The camels were brought to within a few hundred yards of where this was going on, and were made to lie down. There were a large number of them waiting to be loaded. The next thing was that there should be light in order to carry this into effect. I then utilized the search light, which was turned on the camels with a diverging lens, which enabled the rays to spread over a considerable distance, and reduced the brilliancy of the light. It was a curious thing to see the effect on the animals. At first we thought they would start up in fright and be off, but the only thing was that every camel turned its head to where the light came from. At 4 or 5 o'clock in the morning, being all loaded, they marched off. That is a practical illustration of what can be done with the electric light other than for the purposes to which the lecturer has referred. As regards the range-finder described by the lecturer, I think it hardly applicable to a ship of war at sea, under the varying conditions of action. In the first place two observers are required: they must be at different ends of the ship, and in communication with each other. Telephones will not answer when there are guns going off; I think we want something simpler than that, by which the distance can be ascertained by a single person and communicated to the guns. Certainly we have had a very instructive lecture on many interesting subjects.

Admiral COLOMB: I am quite incapable, your Royal Highness and gentlemen, of discussing the paper, but when we come here it is a sort of duty that devolves upon us to endeavour to start a discussion. That has been already well started, but there seems a little hesitancy in following it up: therefore, I rise to congratulate my old shipmate on the lecture, which I have most thoroughly enjoyed. I only wish that I knew something more about the subject, so that I could further enter into it. But I have a little sensation of feeling, after hearing the lecture, that I am rather glad, upon the whole, that I am out of it, because the thing is evidently getting serious, and what one feels about it is that, possibly, if warfare is going to fade off into electricity, it may be a good thing. The only part I am at all capable of appreciating is that part which referred to signalling, and I must say I am pleased to see that there is a possibility of at last getting moderately rapid flashes from a high point in the ship. That apparatus seems to answer very well, but not perfectly, because I am sure, if flashing signals are to be perfect, as they ought to be, something still more rapid than that has to be arranged. I have been much struck watching flashing signals in the Army. I believe that they are further advanced than we are in that part of the science—that their signalling is more correct and quicker than ours. They have the advantage in the Army of having

no other system competing, and some of our competing systems undoubtedly interfere with the flashing system by restricting practice. It is evident that we are going on in the right track, and that results will be ultimately obtained which will be satisfactory to everybody. I beg to congratulate the lecturer heartily on his paper.

Admiral LONG: Your Royal Highness, ladies and gentlemen. Though I am by no means competent to criticize the admirable lecture we have heard, I do not like to remain silent, seeing that Lieutenant Hamilton has taken so much pains, and has got so many beautiful instruments here to instruct us. One lesson we must all learn from the progress of electricity in the Navy, is the advantage of steady, persistent application to one object. It certainly is most wonderful to me to see the progress that has been made in the practical application of electricity to naval things since I first went through the torpedo course in the year 1869. Matters were then in a very different state to what they are now, and I think we cannot but admire the pertinacity, the ability and zeal, with which Officers have stuck to it since then, and have now brought about a state of affairs in which, I believe, we are second to no nation in Europe. There are only one or two points upon which I might make a remark as to communication with lightships. It may not be generally known, that so long ago as 1887, there was a lightship, the "Sunk," in communication with the land by a cable, which passed up through the mooring swivel centre, which was made hollow; it was found very satisfactory. During the manœuvres I was in the Downs: we used to receive telegrams from this lightship, telling us whether any enemy was in sight, and there was no failure at any time. With regard to the three-light signal system, I should like very much to ask Lieutenant Hamilton whether we have that system in use in any ship in the Navy. I think there is a system called the Conz, and also that of Kaselowski, but whether it has been tried in our Service I am not aware. Also with regard to the secondary cells: I should like to ask whether the motion of the boat at sea is found to injure their permanency, whether they are found to wear out more rapidly when used for that purpose than when used on shore. There is no doubt an electrically-propelled boat is a most admirable thing for the use of torpedoes. It may be remembered, perhaps, that on one occasion an electrically-propelled boat went across the Channel, and its progress was so silent that they actually caught a sea-gull floating on the water. That is certainly a point of great importance in torpedo warfare. In Portsmouth Harbour it was quite curious to see how silently the electrically-propelled boat rushed along. The want of speed, I think, is no defect for that purpose, because any boat or vessel going at high speed causes such a disturbance that it becomes at once conspicuous. There is one application that, perhaps, might be made of the motor—I do not know whether it ever has been done, but it struck me it might be a useful way of driving fans for ventilation in out of the way places. Our ships now are full of holes and corners which need ventilation very much sometimes, and I think it possible that the application of electricity might be found to be useful. I do not know that there is anything else which I can say with advantage on this paper. I think Lieutenant Hamilton, as we knew he would do, has treated the subject very fully and very ably, and I congratulate him very much.

Commander MERRYON, R.N.: Your Royal Highness and gentlemen, with reference to some remarks which fell from Admiral Colomb about the Navy being behind the Army as regards the rapidity of signalling, I should like to draw attention to the fact that the conditions of our signalling are entirely different from those of the military. We do not spell out long messages word by word, as is done by the sister Service. We have a code, and it is quite possible for us to do efficiently all our signalling work much slower than is necessary for the land Service. Our distance signals are generally signals referring to our codes, and can be made slowly, carefully, and taken in with certainty. We do not attempt to spell out long messages in which rapidity is of very great importance. Having had something to do with the preparation of the electric flashing-signal light apparatus which Lieutenant Hamilton has shown you, I may state that a great many other systems were eliminated before that was brought out. Our distant night signalling refers to distances of 15 or 20 miles. The Army night limelight signal apparatus, which I think Admiral Colomb was referring to as being so

rapid, is only used at a distance of 2 or 3 miles. Of course the military day system of the heliograph is very rapid, and is capable of being used at long distances. For our daytime long-distance signals we have to depend upon inferior methods, because we cannot get the steadiness of platform necessary for the heliograph; but for night long-distance signalling the comparative slowness is really no great objection to our system, because we are generally using a code and not spelling out words.

H.R.H. the DUKE OF EDINBURGH: I think it is the duty of the Chairman to bring a discussion on a paper to an end. My task is made a very easy one by the admirable paper which we have had before us, and which has left very little open to criticism, as has been clearly shown by the very small number of competitors who have come in to offer suggestions of their own. I can only point out one little omission in the lecturer's paper, which is, that whilst he mentioned the work which is being done at Portsmouth with regard to these matters, he overlooked the fact that there is a port rather further west from which I hailed yesterday. The instruments which you have seen are most interesting, and they are of course immensely in advance of anything we had before. I cannot at the same time help feeling that if we are to trust entirely to electrical communication, and to everything being worked by electricity in a ship in time of action, we shall stand at a great deal of risk. Of course, there is the great difficulty of getting from one part of a ship to another, and communicating, as the lecturer has pointed out, through these bulkheads and armoured decks, and so on; but it is to be hoped means will be found that we shall not have to trust entirely to one single wire, which after all may go wrong. Admiral Long expressed the hope that there would be other applications of electricity, for instance, to the purposes of ventilation. I may mention to him that I saw most admirable little electric fans last year in the Emperor of Russia's new yacht then at Falmouth, which were fitted in all the lower parts of the ship, which had no scuttles. These fans when worked gave a most beautiful current of air; but they had the great drawback of being rather noisy, and I expect a good many people who wanted to sleep would feel inclined to turn off the fans and do without the fresh air. I do not think I am sufficiently an expert to discuss any of the details into which the lecturer has entered. I will therefore conclude this discussion by tendering him our warmest thanks for his most interesting and instructive lecture.

Lieutenant F. T. HAMILTON: The only point, your Royal Highness, in the discussion which I think requires a word from me is that raised by Captain Eardley-Wilmot. I do not think I made it quite clear as to the range-finder for right-ahead work. This ship to which I have been alluding has range-finders for that purpose. They have a 50-feet base line across the bridge, and the instrument, instead of having a wire running round the arc, has it wound on a coil, so that a very slight motion of the telescope will give a large motion of the rubbing contact on the wire. With the instrument so modified you can get the range with accuracy up to 4° or 5° of training on each bow. With regard to the explanation not being mathematically correct, I think I confessed that in the lecture. The mathematical errors in my explanation are two in number, which are made to eliminate one another by the adjustment of a resistance in the galvanometer itself.

Captain EARDLEY-WILMOT: I did not mean your explanation: I meant the instrument was not mathematically correct.

Lieutenant HAMILTON: I think you will find that it is made so with this correction. With regard to the three lights which Admiral Long spoke of, that system has been in use in the flagship in the Channel for some three or four years. They rigged it up themselves in the "Northumberland" originally, and it was afterwards used in the Mediterranean. They found it, I believe, most useful for alterations of course at night and that sort of thing. With regard to the motion of the boat injuring the secondary cells, there is no doubt it does. It must shorten their lives to a certain extent, but there is very little experience of them in any places where the boats knock about at all. The principal place where electric boats have been used up to now, is on the Thames as pleasure boats, and there I do not know that they find very much difficulty. With regard to the fans Admiral Long spoke of, in addition to those mentioned by your Royal Highness, they have one on board

the "Royal Sovereign," fitted up as an experiment by a firm of the name of Blackman and Co. I regret having omitted to mention the Telegraph School at Devonport.

Field-Marshal Sir F. LINTORN A. SIMMONS, G.C.B., G.C.M.G.: We owe a debt of thanks to His Royal Highness for coming to preside at this meeting, where we have heard such an exceedingly interesting lecture delivered by Lieutenant Hamilton. The remarks of His Royal Highness are quite sufficient to show that he highly appreciates the value of electricity as applied in ships-of-war and to war purposes. Having served in the Mediterranean when His Royal Highness commanded the fleet on that station, it was a source of great gratification to me always to see that fleet maintained in the highest order and in the most perfect condition, and to know that every encouragement was given to Officers to develop any project that might be beneficial to the Service of which he is so great an ornament. I ask you to offer your sincere thanks to His Royal Highness for presiding on this occasion.

Admiral Sir E. FANSHAWE: I beg leave to second that.

(The resolution was carried by acclamation.)

H.R.H. the DUKE OF EDINBURGH: I beg to thank you and to assure you it has been a great pleasure to me to be present.

Friday, May 6, 1892.

LIEUTENANT-GENERAL E. H. CLIVE, p.s.c., Governor and Commandant, Royal Military College, Sandhurst, in the Chair.

MILITARY EDUCATION.

By Colonel F. J. GRAVES, h.p., late 20th Hussars.

THE increased application of science to military matters, resulting in the invention and production of weapons of precision of enormous powers of velocity, range, accuracy, and destructiveness, has necessarily increased the need for a more extended and closer study of the art of organizing and leading the huge masses thus armed, so that they may be brought into contact with their opponents at the right time, in proper condition, in such a position, so distributed, and in such overwhelming force that victory will be assured.

To insure victory in the face of smokeless powder and arms of such deadly effect will require on the part of leaders and commanders a developed intelligence, a military knowledge and experience, such as were not thought of in the days of the bow and arrow, flint-lock musket, or obsolete rifle.

No amount of courage, dash, &c., will compensate for incapacity, inexperience, or want of science. This developed intelligence, knowledge, and experience must be based on, and be the outcome of, a sound military education.

The highly educated man, in a military sense, is not, to my mind, a man who has been taught a great variety of subjects, and whose mind is stored with varied knowledge. No; the highly educated man is the man whose mind, being stored with useful information and knowledge, is also trained to apply them at the right time and in such a way as to produce the best effect at the smallest possible cost.

I propose, then, with your permission, to consider the subject of military education from two points of view:—

I. Education *for* the Army.
II. Education *in* the Army.

I commence with the question, When should education *for* the Army begin? And I reply, certainly not at the Royal Military Col-

lege or the Royal Military Academy; again, certainly not a few months before the time for the examination for entrance to these places. This is too late. I think it may be truthfully asserted that one cause of some Officers being passed over for promotion, owing to their having failed in their examination for the same, is that they began their military education too late. Further, that their education, before their or their parents' decision that the Army should be their profession, was carried on on too general lines.

The earlier a youth's future profession is chosen the better for him, and the more hopeful will be his prospects of success should he be suited for it. Delay in this matter is too often fatal. Then the youth's education should be carried out with a view to the special calling in life chosen. A general education, or, say, one calculated to secure an ordinary "pass" degree at Oxford, Cambridge, or Dublin, would be unsuited for a youth going into the Army.

Education *for* the Army should be special, and only those subjects should be taken up that will prove useful afterwards *in* the Army.

Colonel Tulloch, in his excellent paper on the "Battle Training of Regimental Officers," makes the following comparison between naval and military men. He said, "No one can accuse Naval Officers of being mere bookworms, or of caring less about sport when on shore than ourselves; but, somehow, their profession seems to be far more deeply ingrained in their nature than with us. Cannot we soldiers take a leaf out of the naval book and work at our trade as our blue-jacket brothers do? In the Navy such a thing as a young Officer really ignorant of his profession is unknown. Can the same be said of us?"

If this comparison, so much in favour of the Navy, is correct, and it may be, I am convinced that I can give a solvent reason for it. It is because the naval profession is chosen so very early in life, and, further, because the education from early youth has very special reference to the naval life and work in the future.

Permit me now to present two notable examples in furtherance of my argument. First, as to the early choice of the military profession. Sir Charles Napier, when but twelve years old, was appointed to the 33rd Regiment, and shortly afterwards was transferred to the 89th, at Netley Camp, where his father was A.Q.M. General; "and the boy was taken there; thus, without joining his regiment, he was early initiated in the ways of soldiers, by which his natural genius for war was quickened. When the camp broke up for foreign service, he was sent back to Ireland, and exchanged into the 4th Regiment; but, instead of joining, was placed with his brother as a day scholar at a large seminary at Celbridge;" what he had learnt at Netley soon brought forth fruit, as "Charles Napier proposed to organize his schoolfellows as a volunteer corps." This was done, and, young as he was, he was made captain, and commanded in such a way as to shadow forth the fame he afterwards attained to. He began his actual military duties at seventeen years of age as A.D.C. to Sir James Duff.

I now shall quote a case supporting my contention in favour of an early special education as opposed to the too common general education.

In Wright's "Life and Campaigns of Wellington," we read that his mother, Lady Mornington, "sent her son Arthur to Eton. . . . The system of education at that classical institution was not suited to the genius of the infant Hercules, and after a brief struggle with the heroes and poets of antiquity, he was removed. . . . With that decision and energy, which she seems to have left as an inheritance to her noble children, Lady Mornington removed her least-lettered son to the Military College of Angers, in the department of Maine et Loire, where he studied fortification and the art of war under Pignerol, the best military engineer then living. . . . This school was wisely selected. . . . That Arthur Wellesley, the conqueror of Napoleon, should have passed through the forms of Eton without distinction, need not excite surprise or regret. . . . The young soldier soon perceived that Eton was not a field for the exercise of a mind possessing scientific powers only, and capable of being stored with all the theoretic learning of a military school, a description of academy which England at that period did not possess."

Well, the Duke was appointed Ensign in the 73rd on March 7th, 1787, when between seventeen and eighteen years old.

In the Duke's case, what if the "struggle with the heroes and poets of antiquity" had not been "brief," but had been continued to the bitter end, *i.e.*, to the date of his appointment in the Army? Would he have made the mark on history he did?

I do not contend that the foregoing cases prove the necessity of early military education, but I think they prove the great advantage of it, and afford considerable encouragement in that direction.

Of course this matter is mainly under the control of parents, and if they, generally speaking, would look upon the Army as a serious profession, and not as a means of their boys "seeing the world," "passing their time," or obtaining social position, it would be beneficial to the boy, the Army, and the country.

In considering the preliminary education of a boy, it would seem that the three principal means are, instruction by a private tutor, a school, or a special army tutor, often improperly called a "crammer."

With regard to the first, its advantages are, that the boy obtains constant individual and undivided attention, and that he has the sole claim on the assistance of his instructor; its disadvantages are, that the boy so educated often turns out a bit "soft," as he has never had to fight his way among those of his own age, and that few really first-class men, capable of imparting a sound education in the necessary subjects, are to be found who would be satisfied with the pecuniary results of such an occupation. I think the proportion of Officers in the Army who have entered direct from the hands of a distinctly private tutor must be very small.

On the other hand, large numbers have and still do enter military life from our public schools.

Now, the choice of a school is no easy matter. Some parents affect certain schools because "so many of their name have been there;" others think such and such a school has a "crack name;" others because they want their boy to be introduced into a "good set," and so on. I think the main points to be considered are: first, what career the boy is intended for; secondly, what establishment, by its character and results, promises best to launch the boy in that particular career with the greatest prospects of success.

In my humble opinion, the weak point in our public school system in the past was, that as far as preparation for the Army is concerned, the education imparted was of too general a character in some cases, and too classified in others. The heads of many of our large schools have of recent years been waking up to this fact, and have instituted special classes for Army candidates, in which only those subjects are taught that are necessary for the examinations.

This is a move in the right direction, but it should be borne in mind, that the smaller these classes are kept within reason, and the more individual attention that is given the pupils, the greater will be the resulting success.

It was the fact of the point of weakness that I have referred to that called into existence that body of specialists commonly, but, I think, improperly, called "crammers." This body of men are simply special Army tutors; the great majority have served as Officers in the Army; very many of them are Staff College graduates, and many have done good work on the Educational Staff while serving.

Their establishments range from the "two or three boys received, &c.," to those of fifty or one hundred or more pupils. They exist for the special purpose of passing young men into the Army and of preparing Officers for promotion and entrance to the Staff College.

A certain writer in a recent issue of the "United Service Magazine," who possibly held a brief on behalf of the public schools, or was possibly an assistant master at one of them, brought a number of charges against the general body of Army tutors: he says, in substance, that they are insincere, they only try to make money, they are regardless of the character of their pupils, they will not expel a clever though bad boy, they cannot maintain discipline, that their pupils do not turn out gentlemen. Of their assistant instructors, he says they may be "ill-bred, ill-mannered, and unrefined," and their "physical calibre that of a city clerk"—a tolerably strong indictment!

Now I hold no brief on behalf of the Army tutor: I passed from a school, I obtained my promotion without going to an Army tutor, but I emphatically assert that a more "ill-bred," "ill-mannered," untruthful libel upon an honourable body of men could hardly be conceived, and the writer richly deserved the severe public castigation he has received from the pens of several of that body.

There are at this moment many hundreds of Officers serving the Queen who owe their entrance to the Army to the educational help of these gentlemen. Hundreds of boys are taken from schools to finish their education for the Army at the so-called "crammer's."

Do you often, or ever, hear of boys being taken from the Army tutor's to finish their education for the Army at any of our public schools?

Numbers of instructors at Army tutors' are yearly accepted by public schools because of their special powers of instruction. Five passed in this way from one establishment. Do we often hear of the opposite?

I consider the Army owes a great deal to the Army tutor, a class mostly made up of retired Officers, who have brought their military experience to bear in supplying a felt want, and if the school heads desire to regain some of the ground they undoubtedly have lost in the direction of military education, they had better take a leaf out of the book of the Army tutor.

Specialism, if I may use the term, should be the key-note of education for the Army: for numbers of boys who are sent to school receive a general education for years perhaps; then it is suddenly decided to put them into the Service. Two-thirds of the course of their education has to be altered; some subjects are dropped and others substituted; the boy does not seem to get on as he did; the time for examination draws near; competition is keen; what is to be done? "Oh! send him to a crammer." To the crammer he goes, and it is too often found that the lad has been ill-grounded, half informed, knows more of the rules of cricket and football than of the rules of grammar and arithmetic, and that the subjects he does know something of have been imparted to him from a point of view different from that usually taken by a military examiner.

The old-fashioned way of deciding upon which "form" a boy should be placed in on going to school was somewhat this: his age was considered, then he was tested to see how far he had got in Latin grammar, mathematics, &c., &c., whereupon he was told off to a certain form. This may be right and necessary in very early youth, before a boy's future has been decided on; but when this has been settled he should be placed in a class with others working for the same end.

Let us now pass on to the channels through which the Army is entered: these are four in number, the Royal Military Academy, the Royal Military College, the Militia, and through the ranks.

In old days it was much more difficult to obtain an entrance to Woolwich Academy than it was to get into Sandhurst Military College. The examination was more difficult. Now many believe it to be more difficult to pass into Sandhurst, not so much because of any change in the general character of the examinations, but because of the very greatly increased competition for Sandhurst. This is of no very recent growth, for, according to Captain James, a well-known Army tutor, ten years ago the candidates for entrance to Sandhurst were in the proportion of eight to one vacancy, and for Woolwich but three to one. I believe that now the proportion against Sandhurst is even greater. With regard to the course of study at Woolwich, I have nothing to say; it appears to give general satisfaction to the authorities who have to judge of its merits. I would simply say that

if Permanent and Field Fortification are necessarily the principal subjects, Tactics should come next in importance.

At Sandhurst I think tactics and the study of ground and country, both out of doors and on models and maps, should have a more prominent place, and more time given to them.

I heartily endorse the opinions expressed here by Sir Beauchamp Walker and Captain James regarding text books and their use. The science of war advances, the circumstances of war change, and the weapons of war improve rapidly and suddenly, but not so with text books. There are such books in common use even now, some parts of which are already obsolete.

Entrance through the Militia has these advantages, that men who decide on the profession of arms too late to go to Sandhurst can do so thus. They have to pass a literary and military examination, and do duty for some six months with a Militia regiment first. Many also obtain certificates at the Schools for Auxiliary Forces. The military examination for Militia candidates is similar to, but somewhat harder than, the final at Sandhurst. The competition for vacancies is keener.

Entrance through the Militia must not, then, be considered a "back door" way of getting into the Army. The Militia candidate is just as good an Officer, generally speaking, as the man who has entered through Sandhurst.

Entrance through the "ranks" entails the obtaining a first-class certificate of education under Army education rules, or having passed one or other of the recognized tests beforehand, together with the necessary recommendations from the Officer Commanding. This channel applies to such a small proportion of men that it calls for no special remark.

Before passing on to the second head of my paper I should like to say a few words as to the method of treating certain subjects in educating for the Army.

Much greater stress has of late years been very properly laid on the value of "modern languages." How are these too often taught? The tongue and the ear are too often neglected in favour of the memory. The key-note is too often "get marks!" write! read! construe! parse! &c., answer questions in *writing*. To succeed in this the mind and memory need only be well stored with etymological and syntactic facts and rules; the ear and tongue remaining almost strangers to the accent and cadence of so much import in after life.

Again, with regard to history and geography; these should not be taught in a merely general way to boys being prepared for the Army, but taught from a distinctly military point of view; especially geography, which should be imparted so as to include not only the position, towns, mountains, rivers, &c., of a country, but the value or otherwise of these and their effect in the case of invasion or defence. Physical geography should have a much more important place in military education than it has.

I conclude this section, then, by urging the necessity of early decision in the choice of the profession of arms, and early military

education for that profession; further that, within the limits laid down for each subject, all subjects should be chosen and imparted and examined upon, not only with a view to entrance into the Army, but also to usefulness in military life afterwards, as a solid foundation for that which constitutes my second section, *i.e*, education *in* the Army.

On appointment to the Army the military education of a young Officer assumes an additional phase, *i.e.*, practical military training.

His success herein will depend first, upon himself; secondly, upon his Commanding Officer; thirdly, upon the Staff of Instructors; and, fourthly, upon the character and habits of the Officers of his regiment generally, and particularly of those of them who become his intimate companions.

To commence with the first and last of these four. If he, at an impressionable age, throws in his lot with one or two who have no military ambition, who do their work in a careless, slipshod, and perfunctory manner, who vote everything but leave, sport, and social amusement a bore, he will soon be imbued with their spirit and do likewise. Of such a life self is the centre, self forms the radii, and self describes the circumference.

Education by influence is a factor in military training often little thought of, although far-reaching in its results for good or evil.

Sir Charles Napier, when in command of the N. District in 1839, wrote concerning a certain set of Officers as follows: "These Officers really know nothing beyond fox-hunting, dancing, and shooting; they are, however, a very fine set of young men, extremely clever, and zealous also, when put to their work per force; caring nothing for their profession, and thinking it a bore, they know nothing of it. They are, nevertheless, the makings of the finest cavalry in the world, being full of spirit and talent, with good looks, courage, and honour; in fine they are ready for anything but the dull routine of duty. Few of them mean to stay in the Army, and they will not study. I could, indeed, make anything of them in a camp, but it is vain to try in a district embracing nearly half of England. Two things are certain: they will do their work with spirit when brought to the mark; but the devil can't make them read."

Now the "dull routine of duty" brings the young Officer into constant contact with his men, and if that duty is not performed by him with zeal and intelligence, his example must inevitably affect those men injuriously. I believe that one of the elements which goes to make an Officer popular with his men is what they understand as "smartness." This element, when combined with efficiency, strict justice, and kindliness of manner, will make him one whom they will admire, trust, obey, and follow.

In one of Sir Henry Lawrence's essays, we read: "The moral character of a regiment, be it good or bad, fairly reflects the amount of interest taken by the Officers in the well-being of their men. . . . It is not merely the duty of an Officer to attend parade, to manœuvre a company or regiment, to mount guard, to sanction promotions, to see pay issued, to sign monthly returns, &c. The Officer

has higher duties to perform, a duty to his Sovereign, a duty to his neighbours, a duty to his God, not to be discharged by the simple observance of these military formalities. He stands *in loco parentis*, he is the father of his men. . . . There are many idle, good-hearted, do-nothing Officers who find the day too long, complain of the country and climate, &c. . . . Some may smile; some may sneer; some may acknowledge the truth dimly, and—forget it."

One case of the injurious effect of a bad example upon the men will show the logical result and necessary sequence of setting such an example. Sir Charles Napier, when ordering a court-martial to assemble to try a private for insubordination, wrote at the same time to the Commanding Officer of a certain subaltern, that he should "explain to this young Officer what carelessness in duty leads to, namely, commission of crime, and infliction of punishment on soldiers by those very Officers whose conduct set them a bad example. Officers should never forget that they are judges as well as Officers."

I am thankful to believe that the severe strictures passed by such men in former days now apply to a very small and constantly decreasing minority. Most men now enter the Service with the intention of remaining and of making it their profession. Most Officers study their profession, more or less.

To my mind, the power of influence in this connection is so great, that I think Commanding Officers should carefully consider the character and qualifications of troop or company Commanders before posting a recruit Officer to do duty under them.

In a paper read by me in this theatre in 1884, I stated with reference to the actual practical instruction of the recruit Officers: "It is in no spirit of carping criticism that I venture to suggest that the method adopted in the instruction of junior Officers is in very many cases unsatisfactory, and does not attain the object which should be kept in view by those who carry out their instruction."

An Officer is posted to a regiment, and finds himself on the barrack square among the recruits. He goes through the course of drill from the "goose step" onward; is taught the use of weapons to a limited extent; he is taught to ride, shoot, march, &c., and as soon as he is considered efficient in the *performance* of these, he is "dismissed."

I contend that no recruit officer should be "dismissed" until he can *impart to others* what he has learned for himself. This is a most important point, and all depends on the Commanding Officer, the Adjutant, and the Staff of Instructors.

If the Commanding Officer knows what a good system of instruction is, if he has one and can carry it out himself, and can train others to carry it out effectually, well and good, but some Commanding Officers unfortunately leave the whole thing to the Staff of Instructors, and take their chance as to results.

Again, when it comes to drilling and moving the regiment, others are over fond of doing all the drill themselves. Many troop and company Officers are called upon by the General, at inspection time,

to drill their regiments who have had little or no practice in doing so beforehand.

It is easy enough to give the juniors opportunities in this direction. How easy it would be on days when squadrons and companies are being drilled in the spring, under their own leaders, to break them into two or three, and practise a few regimental movements, making the juniors give the detailed instruction for the movements of each unit.

The instruction of the rank and file is not now, as of old, confined to the two or three: under the present system of squadron and company "military training," every Officer is *supposed* to be able to impart instruction; but the gift of imparting instruction in clear and simple language does not fall to the lot of the many, therefore, the greater should be the trouble taken with those who have to acquire it.

If a Subaltern or Captain cannot efficiently command his troop or company, cannot correct the erring, is constantly giving wrong words of command, is frequently finding himself in the wrong place, or moving in the wrong direction, it may fairly be presumed that something is wrong with the system of instruction in vogue in his regiment, or that he is such an unmitigated duffer that no system, however good, could make anything of him. Yet, whatever merit the system possesses, *per se*, it should be borne in mind that it is the man, the living voice and example, that gives it life and force.

In my humble opinion, the weakest point in our armour is this matter of imparting instruction by Officers generally.

With regard to promotion to higher rank, I believe it is the rule in the German Army that before a junior Lieutenant is promoted to higher pay and grade he has to pass a very searching and detailed examination; again, before he can obtain the rank of Captain, he must pass a still more severe test; should he fail in this, and evince a want of capacity as a leader and instructor, he is forthwith transferred to the Ettapen Truppen or some departmental service; thus, while still young, he is posted to a position in which he may still be of use in the service.

In our Army numbers of men have, in days gone by, been passed by boards of examination, or, on the strength of charitably worded confidential reports, who have served on into middle life, only to find their way barred to the higher ranks, and eventually, having been passed over, to "hang on" for the first available pension, and then retire in disgust.

I think we are approaching the end of such a state of things, and that the examinations are becoming more practical, and the results more satisfactory.

As to confidential reports by Commanding Officers and Generals, I think there is a general feeling among the junior ranks that the day of the idea: "Oh, he is such a good-natured, sporting fellow, no one could report unfavourably of him," has passed away.

Having in view the future well-being and success of the candidate for promotion, it is no kindness to him to be easy-going with him during the time he is being instructed in his early service. It is

false charity to speak of him in a confidential report in terms other than express his actual military value. Nay, more, it is dangerous to do so, in view of his possible active employment in face of the enemy —dangerous with reference to himself, and dangerous and cruel with reference to those whom he may command, if he is unfit to do so. Active service before the enemy and on the field of battle, are time and place wherein to give expression to that which has already been learnt in peace. We should *gain* experience on the battle-field, in other ways than by buying it at the cost of our men's lives.

I think the examination tests for promotion may be taken as generally satisfactory in their results. Confined, as they are, to subjects bearing on the demands of military work, and divided into two parts, viz., a paper examination and practical work in the field and model room, the candidate must read and study, and evince ability to express orally and explain to others that which he has learned. It is upon this last point that examiners should seek to enforce an increasingly high standard. It is this that will show how the candidate has been trained in his regiment, as it is mainly the instruction imparted to him there that is the preparation for his examination. To my mind the best available preparation for the paper part of the examination is the "garrison class." Here picked men carry out a regular system of instruction in the necessary military subjects. The value of this preparation may be gathered from the following extract from a letter from an official of the Education Department, dated 2nd May, 1887: " . . . the facts being that among those who had attended garrison classes there were only about half the number of failures as compared with those who went up for examination without going to a garrison class."

I look upon the garrison course as a very efficient stepping stone towards the course of preparation for entrance to and work at the Staff College.

The Officers appointed to the Royal Engineers have, shortly after they join, to go through a two years' course of instruction at the Chatham School of Military Engineering. This course covers an enormous amount of ground. It includes the accurate surveying of country, the laying out of roads and railways, astronomical surveying, the preparation of ground plans for building, fortification in all its branches, mining, military bridges, the attack and defence of fortresses, and all the recent developments of permanent fortification; electricity in its application to telegraphs, mining and lighting, and visual signalling; construction; the theory and practice of all building work; instruction in all material used, stone, brick, iron, wood, &c.; estimating quantities and drawing up specifications; military law and tactics; chemistry as applied to engineering work; steam engines, their construction and repair.

A limited number of Officers go through a course of submarine mining, telegraphy, and photography. A further limited number are sent to Sir W. Armstrong's works at Elswick to learn practically all about iron, and to the London and North Western Railway to learn practically the details of railway traffic management.

Two questions naturally arise with reference to this elaborate course. First, can thoroughness of instruction be obtained in the time allotted? Secondly, is it quite wise to send Officers to the School of Military Engineering so early in their service?

A Line Officer is allowed to attend two garrison courses, once *after* promotion to Lieutenant, and once *after* promotion to rank of Captain. An artillery Officer must have six years' service with troops before going through the senior class at the Royal Artillery College. There are several weak points in the School of Military Engineering system I may be permitted to refer to.

The purpose of a garrison course is ("Queen's Regulations," sec. ix, p. 48) "to assist Officers in preparing for examination," and the examination usually comes shortly after the end of the course; but at the end of the Chatham course there are no examinations whatever. There is no test by examination of the work done or of the knowledge gained. Not only so, but the engineer Officer who has finished the course at Chatham is never again (in this country) examined in fortification or surveying except he desires to enter the Staff College. On the other hand, the Government of India insist that all Royal Engineer Officers who elect for permanent Indian service shall go through a course of instruction in professional subjects *after* they attain the rank of Captain, *i.e.*, after some eight to ten years' service on an average.

I referred just now to the senior class at the Artillery College. I regret that the limits of this paper prevent my doing more than briefly touching upon the work done in that valuable institution. For full and most interesting information I refer you to Major Baker's excellent pamphlet "The Artillery College," published by Harrison. With a staff of some thirty instructors, and a "morning state" showing throughout the year a strength of from 250 to 350 of all ranks under instruction, some idea of the importance of the College may be gathered. The courses are as varied as they are numerous. The "senior class," two years' duration for Officers of not less than six years' service; subjects: mathematics, armour, chemistry, metallurgy, manufacturing, electricity, heat, steam, and mechanism.

Next comes the "Firemaster's Course," open to any Officer below the rank of Major.

Then the "Special Class" for detailed Officers. Next, the "Position Finding Class."

Next, the "Officer's Long Course," lasting eight months; carried out at the College, the School of Gunnery, and including visits to Okehampton, Lydd, and Golden Hill.

"Store Accounting" comes next, then the "Junior Class," which consists of Officers appointed direct from the Militia, Colonial Military Colleges, or the Colonial Forces.

Why, may I ask, have not Officers appointed to the Line from the Militia a course of surveying and fortification when, say, they are dismissed their drills?

Then we have classes for Gunnery Lieutenants, R.N., for Royal Marine Artillery Officers, Torpedo Lieutenants, R.N., a Promotion

Class, Field Sketching Class, Master Gunners' Class, N.C.O.'s Long Course, a Class for Telegraphists, for Warrant and N.C.O.'s of Indian Ordnance Department, Chief Armourers, R.N., for Armourer's Mates, R.N., and for Military Artificers.

The system at the Artillery College is strong where the School of Military Engineering is weak, for there are examinations at the close of all the courses at the former, and further, lads are not sent to the College upon appointment.

I must now refer to the Staff College; its name explains the purpose for which it exists. The details of "qualifications requisite for admission" fill a page of the Queen's Regulations, commencing with "a service of not less than five years previous to examination." The course, lasting two years, is looked upon by some of the unthinking as "a good loaf," or "a comfortable escape from regimental duty," and a proposal was made some time ago to reduce the time of residence there. I think it was wisely decided that the course was by no means too long. The time spent there is no "loaf," and the instruction obtained there must be of value to every Officer, whether he obtains employment on the Staff or not.

I am not in accord with the present distribution of marks at the entrance examination for the subjects of "Fortification" and "Tactics."

Twenty-eight vacancies are offered for competition annually, of which only three may be filled by Officers R.A., and two by Royal Engineers. Now, for these Officers, "Fortification" is a most important subject, and at the Royal Academy they have already received a first class education in it before joining, at the Royal Artillery College, or at the School of Military Engineering afterwards. So much so, that inasmuch as the scope of the examination for entrance to the Staff College is limited to that specified for Captains before promotion to Major, they ought not to require any special preparation in this subject for the Staff College, but should make full marks, and they are in a favourable position compared to Line Officers by thus having more time to give to the study of other subjects. I look upon "Tactics" as all-important for both "Line," R.A., and R.E. Officers alike. For "Line" Officers, certainly, Tactics are far more important than "Fortification," yet 600 marks are allotted to each.

I conclude that as but five R.A. and R.E. candidates enter the College to twenty-three Officers from the Line, &c., Tactics should have, say, 900 marks allotted to it, and Fortification should have about 300.

I use this proportion to express my view of the relative value of the two subjects to the Officers of the Army generally.

To the young aspirant for Staff employment I would say, "Enter the Staff College while young." The examination for and work in the Staff College should be easy to any Officer who has passed with honours from Sandhurst or Woolwich, and has gone through a Garrison Class, the Artillery College, or School of Military Engineering with credit.

The system of attaching Staff College Officers to arms of the

Service other than their own to learn interior economy and drill, &c., should be beneficial if carried out properly.

The Officers should not be regarded as onlookers in the corps to which they are attached; they should share in the ordinary duties as fas as possible.

The system of "Staff Tours" during which memorable battle-fields are visited, examined, and discussed is a move in the right direction in which many Regimental Officers would like to have a share.

We must all admit that the encouragement given to Officers to study modern languages by the recent introduction of examinations for Interpreterships is having the desired effect. I am not quite clear, however, that the division into two classes is the best plan; I incline to the belief in qualification for Interpretership alone.

Outside the Staff College and regimental training, education *in* the Army may almost be described as "technical." In it are included gymnastics, fencing, musketry, pioneering, field engineering, ambulance, signalling; the Veterinary School with its lectures on shoeing, saddlery, and forage, &c.; schools of instruction for auxiliary forces; the Army Service Corps School of Instruction where Officers are taught to judge the quality of provisions, to understand the system of baking bread and the killing of bullocks, &c., to which may be added the "School of Cookery."

On the other hand, questions of theory find ventilation in this, the Royal United Service Institution, the Indian United Service Institution, the Dublin Military Society, the Aldershot Military Society, the Royal Artillery and Royal Engineer Institutes, &c.

The value of such an institution as this can hardly be estimated, and I confess it is a matter of astonishment to me that the number of members is not fourfold what it is.

The usefulness of the contents of the reading room, map room, and library is not to be measured by the amount of the subscription.

Before passing on to a most important point in military education and training, I would like to say a few words about inspections. One or two days, to my mind, is too short a time to give to the inspection of a regiment.

There is not much time to find out the individual value of the Officers, especially those of junior rank, concerning whom there are two points of special import: can they handle and instruct their men, and do they study their profession? To find out these things effectually takes time. With regard to the latter, a plan I adopted when in command of my regiment might be found useful. One afternoon I directed the Adjutant to issue an order that every Officer should send to orderly room by 10 A.M. the next day all military books of whatever description in his possession. When my routine work was done, I examined these libraries; some were encouragingly large, varied, and well chosen; others small; one or two not up to regulation. I not only considered the number and character of books in each library, but I carefully examined the condition they were in. Some showed signs of regular use; others, though in a

sense old, were fit to sell as new. I found, in fact, that the general estimate I had formed touching the question of study was borne out by my examination of the books. An Officer brings his books for the Inspector's examination, but how seldom is any notice taken of them!

Further, at an inspection, I think the drill instructors should be seen and heard at work with squads of recruits.

Further, too much notice is given beforehand as to the date of inspection; there is too much special preparation for it, and, as a result, it is too often no criterion of the *average* work of the corps.

I now pass on to consider a most important point: the training of the eye. I am convinced that in this we come far short of what might be accomplished. The value of the "object lesson" is now well recognized by the general body of those who train the young. You can train a man through his powers of hearing and remembering what you teach him; but you can train him more effectually by instructing him through his powers of vision as well.

This applies very specially to instruction in outposts and reconnaissance during the winter months. How often the custom has been to take a regiment out and form a line of outposts along a given road or river: the positions for the reserve, supports, and picquets are chosen, the vedettes are posted, and they stand for hours looking to their front at—nothing. It may be a cold day with a biting north wind, the men know that no opposing force will come, and there is nothing to attract and keep up their attention. How then can interest be expected or maintained? The same applies to reconnaissance.

Recognizing the weakness of such a system, I always divided my regiment into wings under Officers detailed in turn. Umpires were appointed and schemes issued. One wing would take up a line of outposts; the other would reconnoitre and attack. The Officers Commanding and the Umpires sent in written reports, and the Lieutenants sent in maps. Again, one wing would escort a convoy made up of the regimental transport, and attempt to gain a certain point, while the other would find and attack. Reports as in the first case. What was the result? A marvellous display of keen interest on the part of all ranks. Remarks on the day's work were posted up in the different messes, the corporals' room, canteen and recreation room, and I was informed were the basis of keen and animated discussion.

Now, in training the eye, a difficulty arises, inasmuch as the zone of sight of a group or individual, say, in a line of outposts is in most cases limited to the extent of ground or number of objects watched, to the sphere of work allotted; the interest, then, of the individual is too often limited to that sphere. This was brought home very forcibly to my mind by overhearing, one day, the question, "Well, so-and-so, what happened your way to-day?" This set me thinking. I came to the conclusion that it was not enough to explain, beforehand, the general and special ideas, and to remark on the day's proceedings; so, in 1884, I tried a system, with the permission of my Commanding Officer, which produced excellent results.

The regiment was divided into wings and worked as before described, then, after stables in the evening on the same and following day, those who took part were assembled in the largest available room, where I had prepared a model such as you see before you, showing the ground they had worked over, and the positions occupied, &c. The model is formed by placing together six or more barrack tables, covered with blankets, under which are placed bolsters, hay, straw, or anything that will show the feature of the ground. Brushes are used to show woods, string for railways, strips of brown and blue paper for roads and rivers, matchboxes for houses, chalk marks for fences, and dominoes, beans, or matches for men.

The model was then explained to the wing, and the Officers were directed to place their men on the model and move them as they had done on the actual group. They were questioned as to the route taken and what was observed, and where. Mistakes were explained and general remarks on the work made. The rank and file were also questioned. The interest shown and the progress made by all ranks was most encouraging.

The model was useful in yet another way. I made models from a local map and ordered ten or twelve non-commissioned officers into the room, where pencil and paper was supplied them, and then and there they had to reproduce the model on paper.

By this means the young Officer and man not only hears about things but he *sees* them in miniature, he compares the real with that which represents it, his mind is enlarged, and his eye is trained.

You have but to make the model large enough and use a screen, to enable you to work out regular schemes.

During squadron military training, my squadron leaders used these barrack-room models, during their lectures, with marked effect. By this means the eye can be trained in a way that no book reading will effect; and the young Officers and men will gather the reasons for many things they carry out in the field.

The successful use of models in this way depends largely upon the lecturing powers of the Officer and his tact in instructing and interesting his men.

Some "don't believe in lecturing their men;" they overlook the difference between "lecturing men" and "lecturing *to* the men." They may not have gifts in that way, and their prejudice is a further hindrance.

Then there is the young gentleman who thinks it is quite sufficient to read a few sections out of the "red book" to his men because he is too lazy to work up the subjects himself. He does not produce much effect. Then there is the loud-voiced, heavy-heeled young gentleman, who means to let you know that he is "all there." He commences with a "wisdom-will-die-with-me" style, he browbeats his audience, and the first man who makes a mistake is declared to be "the biggest fool in the world." He does produce a marked effect in the shape of a prompt and free issue of a "wet blanket."

Then there is the man who studies his profession, who masters his subjects, uses simple language, whose questions have nothing of the

Chinese puzzle about them, whose manner is encouraging and helpful, whose men feel that he has something worth knowing, and that his chief object is to share that knowledge with them.

Such Officers produce the right effect in increased efficiency and knowledge among those whom they command.

The next step is the training of the eye on a larger scale on garrison models and maps, then out of doors in the examination of reports on, and making maps of, country, positions, roads, and rivers: then the further training of the eye to be obtained at autumn manœuvres on a large scale.

One great difficulty in the way of the latter is our present system of garrison distribution. It was, no doubt, necessary in the days when the country was deficient in police, in railway and telegraph services, to have troops scattered in small garrisons all over the country; but the police force is now ample; railway, postal, and telegraph services abound, and yet our troop distribution remains almost the same.

"What about the territorial system?" says someone, in reply. I would simply remark that, under our present system of Government education, the rural population is steadily dwindling; the men are being attracted in increasing numbers to the large centres of population where the bulk of our recruits are now obtained, and thus, one of the main principles of territorialism is being slowly, but surely, undermined.

If the Government cannot do away with small, dispersed garrisons and establish large garrisons or camps, it should find the money and give facilities for holding autumn manœuvres on a much more extensive scale than obtains at present. Not to do so is "penny wise" in times of peace, but many "pounds foolish" in time of war.

We require far greater opportunities for instruction in duties which bring all arms into combined action. To repeat a simile used by me here on a former occasion, "as the hearing of the ear may bring the foot into readiness to move; as the seeing of the eye reveals the direction for the blow of the hand; as the foot may not say to the hand, 'I have no need of thee'; and the hand without the guiding eye would strike wide of the mark, so cavalry, artillery, and infantry with their auxiliary services should have ample opportunities granted them of cultivating those inter-relations for exercising those characteristic and individual functions which, carried out in unison, weld eye, ear, hand, foot, and body into one corporate entity, form one harmonious whole, complete and perfect in all its parts, and mobile in all its movements."

Owing to the advance of warfare as a science; owing to the enormous scale, as to numbers employed, upon which most wars must be waged in the future; owing to the great progress made within recent years in the manufacture and deadly use of arms of precision; owing to the greater freedom, self-dependence, &c., engendered amongst the Commanders of small bodies of men, and amongst the rank and file themselves, it is all the more necessary now to work out on a large scale during peace problems and combinations of movements that

may be forced upon us in war. Not to do so is, as it were, to advertise the performance of a military tragedy for which the most perfect scenery is obtained, actors engaged, and beautiful dresses provided; to open the doors and admit the public to see—what? the performance attempted without previous rehearsal, and for which the actors have, consequently, but very imperfectly learned their parts from books.

What applies to the commanding, leading, and work of the three arms in unison, also applies to the departments of supply, transport, and hospital. All these departments require exercise in times of peace in conjunction with large mixed forces. To expect them to do their work efficiently in times of war without such antecedent exercise is, so to speak, to enter a good horse under a heavy impost for a great race, upon the winning or losing of which depends a national fortune, to bring him to the post ill-fed, ill-groomed, ill-equipped, and out of condition, to be disgracefully beaten by an otherwise inferior animal.

Autumn manœuvres, flying columns, and cavalry manœuvres have recently obtained a firmer footing in our military system; but to my mind the doses have been too homœopathic. If our system of garrison distribution were based on modern requirements and not upon circumstances long since obsolete, the question would present fewer difficulties.

Sir Charles Dilke and Mr. Spencer Wilkinson, in their book "Imperial Defence," say, "The British Army at home has no Generals . . . and can have none until its battalions are settled and grouped into brigades, divisions, and army corps."

While I differ with the authors as to what they intend by the term "settle," I concur with the idea of forming garrison brigades and divisions where possible, but to increase the camp at Aldershot to the capacity for an army corps would entail the buying of large tracts of land, adding extra ranges, and building barracks to an extent that would make the strongest Government tremble for their existence. The author's statement as to our having "no Generals," I pass with the remark by a wiser man than they or I are or am, *i.e.*, "all trades require apprenticeship save one—critics are ready made!"

The necessity for a thorough military education and training for our young Officers is increased by the fact that vast strides have been made educationally among the rank and file.

Before the year 1887 a recruit had to attend school for six months, or till he obtained a 4th class certificate of education. The examination for this certificate comprised the copying of about five lines of print, containing words of two syllables, working six questions on the first four rules of simple arithmetic, one example in notation, and one in numeration. This standard was about equal to that passed by children of eight years old in our civil schools.

The general education of the country having advanced under the Voluntary and Board School system, it was recommended by a special Committee, of which Lord Harris was Chairman, to abolish the six

months' compulsory attendance at school, and also the 4th class certificate. This was done, and now attendance at school is voluntary, but promotion to non-commissioned officer's rank depends on the possession of a certain certificate, according to rank.

I think a suggestion offered me by an Officer of the Education Department might prove of value in practice, *i.e.*, for Colonels to select promising privates and prevail on them to attend school, with a view to obtaining a 2nd class certificate, relieving them from some duty, such as night guard, &c., their promotion to depend upon other qualifications as well as education.

Although some men thus obtaining a 2nd class certificate would not be promoted, for various reasons, yet they would be benefited by having received a degree of instruction and knowledge likely to be useful afterwards in civil life.

That the progress of military education among the rank and file is satisfactory will be gathered from the tables I now venture to submit for your consideration. I have taken them from various Returns given to me by Officers of the Education Department, and they present the case from several interesting points of view.

Percentage of N.C.O. and Men in possession of Certificate of Education according to Class.

1873.		1881.		1891.	
1st class.....	0·75	1st class.....	1·00	1st class.....	1·26
2nd „	8·30	2nd „	15·31	2nd „	19·71
3rd „	11·35	3rd „	12·94	3rd „	17·18
4th „	9·30	4th „	30·89		
Not certificated.	70·30	Not certificated.	40·37	Not certificated.	61·85
	100·00		100·00		100·00

Had the 4th class certificate been retained, it is obvious that the percentage of "not certificated" shown in 1881 would have been greatly reduced in 1891.

The following table is taken from a Return which is not now issued: it is in G.O. 121, Sept., 1883, and sets forth the percentage of candidates who passed their examinations. I only take the branches of the Service of a strength of 1,000 and over:—

1. Foot Guards.....	97·72	4. R. Engineers	90·60
2. Cavalry.....	91·45	5. Infantry	89·33
3. C. and Transport....	90·99	6. R. Artillery	87·65

The next set of tables shows the percentage of certificates obtained in branches over 1,000 strong, according to "strength." They are chosen from the period before the abolition of the 4th class test and after:—

1884.		1891.	
R. Engineers.....	64·21	R. Engineers.....	60·84
M. S. Corps	58·90	M. S. Corps	57·84
A. S. Corps	47·49	A. S. Corps	53·38
Cavalry	43·94	Cavalry	50·93
Foot Guards.....	38·36	Foot Guards.....	42·18
R. Artillery	36·88	R. Artillery	40·19

Thus showing, that in spite of the abolition of the 4th class test, 15·53 per cent. more certificates were obtained, and further demonstrating the steady advance of education among the rank and file.

This is eminently satisfactory; but besides the education imparted necessary to obtain a certificate of education as at present, I think it would be a great gain if there were special classes and courses for Line non-commissioned officers and men at the different centres where garrison instructors are located, so that they might be instructed systematically in surveying, sketching, field works, and the first principles of tactics. The foregoing tables should suffice to prove that the soldier is no longer, if he ever was, an unthinking, automatic, muscular machine, but an increasingly intelligent entity, to be encouraged in all those necessary paths of self-culture and control which will fit him to return at the end of his military career to the ranks of civil life as a useful addition thereto, and not as an object of distrust and suspicion, too often to end as a burden upon the poor rates.

Considering the steady growth of education among the rank and file, the young Officer should ever remember that he lives and works amidst the changing circumstances and varying requirements of a rapidly developing science and art.

Regarding it as a great privilege to serve the interests of an Empire so magnificent, whose history and traditions are so glorious, and whose prestige is so widespread, he should be imbued with a full sense of the fact that his responsibilities are commensurate with his privilege, and while he seeks to qualify himself as an efficient instructor and leader of men, he should ever be an industrious and zealous seeker after fresh knowledge, and maintain the attitude of a patient learner, and even in the consciousness of a degree of attainment to remember there is always more to be attained; thus learning, thus working with his own, his regiment's, his country's, and his Sovereign's honour dear to his heart, he is bound to become a useful and efficient unit in that branch of the Service to which he belongs, and will surely prove the truth of the saying, "Diligentia facit famam."

Lieutenant-General R. N. Lowry, C.B.: I will not venture to follow the gallant reader of the paper through the most interesting details which he has brought forward this afternoon. There are two or three remarks, however, that I would like to make. Colonel Graves has, to my mind, treated a vastly important subject in an admirable way. No one can have heard this paper without, I think, having had conviction borne in upon him how much an earnest, zealous, and able Commanding Officer has it in his power to do for his Officers and men. I entirely agree

with almost everything said, especially as regards the first part—the education of Officers for the Service. It cannot well be begun too early, and cannot possibly be made more apt than it should be for the special preparation of young men for the profession of their choice. The great difficulty is to get youths and their parents to ascertain and fix early in life what is the bent of their aspirations in the matter of profession. They do not, too, generally arrive at and decide on that until rather late; but if they could arrive at it, I entirely agree with the reader of this paper, that it is most important to turn them early to special preparation for it. I think Colonel Graves has paid a very deserved compliment to those so-called "crammers," who prepare young men for the Army. The Service is deeply indebted to them, and they have not always been appreciated as they should have been. There are amongst them some of our ablest Officers. These Army tutors have, in very many cases, proved of incalculable benefit to the young men who come to them to be prepared for entrance into the Service. I could have wished, however, that, while tendering due credit to these able men, Colonel Graves had alluded to other factors certainly not less important to the fitting preparation of young men for the Army. Over twenty years ago some of us were assembled, in the theatre of this Institution, under the presidency of the late Duke of Wellington, to found the United Service College at Westward Ho, a college which has been in active operation for all these years, under the chairmanship of General Sir Charles Daubeney, and has been doing, in a quiet way, admirable work in educating young men for the Services. A few years later another valuable institution, with which I was also long and intimately connected, and in the good work of which I am still deeply interested, was founded—I allude to the Oxford Military College. Mainly originated by the late General Eardley Wilmot, it was afterwards admirably developed and presided over by the late Colonel Duncan, M.P., who threw his great zeal and energy and ability into the work. I think it must be within the experience of most Officers here that those two colleges have done admirable work for the profession, and that the training at the college at Cowley, in the way of horsemanship, of swimming, of drill, and of athletics of all kinds—side by side with the highest mental culture—has been of the greatest possible advantage to the Service. I should like also to include the Military College at Kingston, Canada. That college has already prepared a number of Canadian young men, who have done honour to themselves, to British North America, and to the Service, and I am quite sure the more we strengthen and support such public institutions for the training of young men throughout Great Britain and the Empire at large, the better it will be for the Service. Let me say, as regards the second part of this admirable paper, though the lecturer did touch upon it very forcibly, that I do not think we can attach too much importance to the after-instruction given to our Officers by this Institution. I would, with all my heart, our young Officers—naval as well as military—became members of it earlier in their service, that those stationed at Aldershot, Woolwich, Chatham, Portsmouth, and all parts within reasonable hail of London would come here in increased numbers, and have their education developed and matured by taking greater advantage of the Royal United Service Institution.

Captain JAMES: Mr. Chairman and gentlemen, I am sure that, in the first place, we owe a debt of gratitude to Colonel Graves for the very excellent paper he has read to us this afternoon. In the remarks that I propose to make I shall limit myself almost entirely to the consideration of the education of Officers before they enter the Service, and to the education of Officers when they have obtained Her Majesty's commission. I dare say a great many of you in this Institution are aware that with the subject of the first portion of my remarks I am somewhat intimately connected; but I ask you to believe me when I say that I shall put aside entirely my professional capacity, and merely aim at the ideal I have always set before myself as being that which should be before the minds of those who devote themselves to the preparation of the Officer corps, which in the British Army should be the equal of that which exists in the German Army. There can be no doubt that Colonel Graves has hit the right nail on the head when he said that, in a very great measure, you cannot begin the education of an Officer too young. He instanced in that regard the Navy. No one ever cast a slur upon the Navy

because their men are not taken either from the public schools or even the Universities, and we know that in professional capacity and in knowledge of their work, the British naval Officers stand second to none in the world. I wish to say that there is one important fact which is becoming more evident almost every day, and which a very large number of people in England do not appreciate at the present moment, and which, I venture to say, no educational establishment whatever which is devoted to the preparation of younger boys at the present time takes adequately into account, and that is the desirability of an English Officer being thoroughly acquainted with foreign languages. An English Officer who does not know German is like a one-eyed man: half the military literature of Europe, and that by far the best half, is a sealed book to him. And I can say, from a very considerable experience of young men under my charge, there is, so far as I know, only one school in England which devotes sufficient attention to the education of boys preparing for the Army in this particular. There has been recently started a college at Stony Stratford,[1] which undertakes the preparation of boys in this particular line, viz., that at an earlier age than it is at present possible at any of the public schools in England, boys shall be prepared for the profession which they afterwards propose to pursue in life. So far with regard to the preparation of Officers before entering the Army. With regard to the education of Officers in the Army, I can confirm very strongly what Colonel Graves has said. When I first started my present business I constantly had with me a large class of Officers who wished to be prepared for promotion. These men, in nine cases out of ten, were those who had got in in the old days, and had not been through the modern military curriculum. They had entered the Service without difficult competition: they had not been induced to pursue military topics, and they felt that unless they received some special preparation they would be unable to pass the promotion examination. That class has now died out almost entirely, or has reached Field rank, and the more junior Officers now in the Army, in a very large number of instances, pass their promotion examination without any assistance whatever. That is, I think, a proof of the advantage which the Army at large has received from the additional examination pressure which has been put upon them. There is, I believe, still a great deal to learn with regard to education in the Army. If I may venture to say so, our education in the Service is for the Officer a great deal too theoretical, and not half enough practical. We are apt to think that there are only four subjects necessary for military salvation—topography, fortifications, tactics, and law—excellent servants, but very bad masters; and they have been put rather in the position of masters than that of servants to the men who are to make use of them. There appears to me to be a theory amongst a certain class of military educationalists that everybody can be a first-class topographist, or if he is not he ought to be. And it seems to me the times of instruction and the times of examination are directed far too much to producing a series of impossible geniuses in this particular direction, rather than seeing that they have a practical knowledge of the work which they would be called upon to do in the field. I will venture here, perhaps, to go outside of what I laid down as the subject of my remarks, and will say that this is even the case in the practical company instruction which now goes on; that there is too much theory and not enough practice. I think there is a great deal of knowledge of a practical character which it is extremely hard to test by examination, and which can only be tested by the superior Officers of the Army, seeing that those who come under their command are thoroughly well acquainted with what ought to be their everyday knowledge. I could tell a number of humorous anecdotes on this head, were I to trouble you with them, but I think, perhaps, they might lead to laughter, and perhaps trains of thought which would be injudicious in a judicial assembly of this kind. I know destructive criticism is worth nothing, and unless you are prepared to propose something better you ought never to criticize at all. My view about these promotion examinations, as applied to Officers, is that instead of having the large number of questions, as is usually the case now-a-days, it would

[1] St. Paul's College, Stony Stratford, Bucks. Letters should be addressed to the Head Master there.

be much better if the questions were fewer in number, but required a greater exercise of intellect to answer them. That is the system upon which the German examinations for entrance to the Staff College in Germany are conducted, and to my mind we might very well take a leaf out of the German book in that respect. I quite coincide with what Colonel Graves says about the examinations for entrance to the Staff College. I do not think stress enough is put upon tactics. I think that the tactical examination, for instance of the Staff College, and also tactical examinations generally, have improved of late years, but I hold there is still room for further improvement. I may draw attention to the very curious way in which the course of the examinations is determined in England. We have, in the instance of the Staff College, an examination on the subject of fortifications, which is divided into two parts, the majority of marks being given to field fortifications, and the minority to permanent fortifications—in my opinion a very reasonable and proper distinction. When the authorities first started the examination in permanent fortifications at the Staff College, they said it would be limited to the elements of the modern French system and the polygonal system, but when the first examiner was let loose on the Staff College candidates he proceeded not only to examine on the elements of the modern French system and the polygonal system, but also to examine on coast defence and attack, and defence of fortresses. And then came in the red-tapeism to which I object. Naturally the candidates expostulated; and instead of saying what ought to have been done, admitting that the paper was a mistake, the authorities in question said, "Of course the elements of the modern French and the polygonal systems necessarily implied the attack and defence of those systems." You might as well say that the ABC includes syntax and prosody, when in the ordinary meaning of the term it does nothing of the sort. I say so long as you have examinations you necessarily must have examiners. I am inclined to look a little after the examiner, and the only way of looking after the examiner is to do this, let us know who he is. At the present moment the military examination papers are the only papers set in the wide world as to which the examiners who are selected are men of whom you know nothing whatever, and whom you cannot get at. I believe in the value of publicity. I believe in having someone to hang, and even an examiner is not always perfect, and if he should strain his powers, for goodness sake let us be able to get at him, but we cannot do so at the present time. Then as to text-books, they are in my mind an abomination. Jones' opinion about tactics are no better than Smith's or Brown's: very likely they are not as good, and I certainly think it is a great mistake to say that you shall get your tactical knowledge from any one particular fountain head. The same thing applies to every text-book. Take, for instance, the text-book on fortifications used at the Royal Military College, Sandhurst, with which you, Sir, are no doubt intimately acquainted. That book dates from the year of grace 1884.

The CHAIRMAN. A new edition is being got out now.

Captain JAMES: In 1889 there was prepared a second volume—I do not think it is any straining of terms to say that a second volume was produced in the shape of addenda and corrigenda, which numbered twenty-nine pages, the original book having 193.[1] When I was a Cadet at Woolwich, or after I got my commission, I was examined on the question of education at military schools, and I said, amongst other things, that I thought it was a great mistake to require Cadets to write their own text-books. That apparently is not thought to be a mistake now, because in order to correct the text-book on fortifications that is used at the Royal Military College, Sandhurst, and by Militia Officers preparing for promotion, and to put in the necessary corrigenda, is an operation which requires about a fortnight's work at a moderate calculation. There is another reason why I object to text-books. Text-books multiply. In my opinion if you have a definite Service regulation, that regulation should be kept, and no other should be adopted. With the greatest respect to the text-book which is coming out, I hope you will stick to the Chatham

[1] Moreover this corrigenda came out after "Instruction in Military Engineering," vol. i, part 1, dated 1888, and differs from it in many points. This difference in official text-books tends to confusion, and is much to be deprecated.

book as the real fountain head of authority, because I find that whenever you have a difference in text-books you are very likely to have Brown's opinions, Jones' opinions, and Smith's opinions, which are not, perhaps, on the whole as good as those which are given by a Committee of Officers, who have special knowledge on the subject. There remains very little for me to say. I am quite sure of late years we have made great progress, but I am convinced of this, that unless we really recognize in the Service that education is a desirable thing, we are not likely to make the progress that we might. There is a very curious commentary I might make to what I have said: I believe an Officer can get leave to go to the Derby, but he cannot get leave to study for the Staff College. Whether the Service is likely to be the better by his visiting the great saturnalia or by his devoting his leisure time to the study of military science is a point which I have the greatest pleasure in leaving to this audience.

Major C. M. WATSON, R.E.: I should like to say a few words about one point in the paper, viz., questions of the education of engineer Officers. To me, as an engineer Officer, of course this seems to be a very important point, and though Colonel Graves has said some things with which I agree, there is one remark he made with which I am not in accord with him. He gave a long list of subjects that engineer Officers ought to learn, and I am sorry to say, for the sake of the young engineer Officer, it does not include them all; I wish it did. In addition to the subjects in that list they have to learn the whole of the duties of an infantry Officer as well as their own. Colonel Graves suggested that the engineer Officer, when he left Woolwich, should not go to Chatham for some time. Now it seems to me that if he did not go Chatham he would not be an engineer Officer at all; he might be so called in the Army List, but he would be totally useless for the duties of his profession. It is not until he has had those two years at Chatham that he is really of any use, and is worth his pay. It is really important that engineer Officers should receive a thoroughly good education before they are sent out as reliable Officers. I might mention that this very point was referred to a Committee, of which Lord Morley was President, in the year 1885. Some people then thought the Chatham course was too long, and a Committee of distinguished Officers was appointed to see whether it could not be shortened. After a long investigation the Committee, in their report, gave it as their opinion that "in order to keep up the high character of the Corps of Royal Engineers it is absolutely necessary that every Officer should, at some time during the earlier part of his career, pass through the whole of the Chatham course of instruction." I entirely agree with Colonel Graves that it would be an admirable thing if engineer Officers could go back afterwards for a further course, and if at the end of that further course there could be an examination; but in order to enable this to be done it would, of course, be necessary to increase the corps, and it might be difficult to obtain authority for that. There is one point I would like to allude to with regard to the course at Chatham. In addition to our engineering work, some Officers every year are taken abroad to visit the battle-fields, in order that they may have practical acquaintance with tactics. It has struck me that it is rather a pity that cavalry and infantry Officers could not, in some way or other, have the same advantage given to them. For example, those Officers who had most distinguished themselves in passing the promotion examination might be given the opportunity of practically studying the battle-fields abroad.

General Sir ROBERT BIDDULPH: The importance of the subject of the lecture to which we have listened to-day is so great as not to need any apology on the part of any of those who join in the discussion. It covers a great extent of ground, and therefore I do not propose to follow the lecturer into every part, but there is one—the first part—upon which I wish to make a few remarks, that is, on the subject of the education of Officers for the Army. All are agreed that every man entering on any special line of life must have a certain amount of general education before he begins his special line. The point on which difference may arise is where or at what age that line should be passed which divides the general from the special. I gather from the lecturer that he is of opinion that it should begin comparatively at a very early age, and he advocates very strongly the early choice of the Army with a view to the lad being trained solely with a view to a military

future, and I gather him to mean, also, solely on military subjects. I venture to think that is a mistake, and I give my reasons for it. It is a very great object in our Service to have a large number of candidates. If we restrict our numbers too greatly we must surely have a poor result. If you insist upon nothing but a military training you will obtain only a limited number of candidates. Another thing is you do a great injustice to those who fail. Everybody cannot get in, and if those who fail find themselves hopelessly left out for any other profession, then they complain that there is nothing left for them to do but to emigrate to Australia and to become cattle drivers. In that case you are doing a very great injury to the young men who have been prepared. Moreover, it is a great objection that you should educate young men for the Service apart from the young men who are going into public life, or who are training for the liberal professions. You must not have a separate class for the Army; certainly not in these days. Remember that above all things you want your Officer to have the feelings of an Englishman, because he will have to command Englishmen, and if you educate your young man in a very narrow school, perhaps abroad, where he can get quite as good a military education as in England, he will come back an accomplished man, perhaps, but in a narrow groove; he will not have the feelings of an Englishman, he will not understand how to command Englishmen, and in these days, where classes are brought together in a way that they have never been before, you must keep in touch with your countrymen if you are going to lead them to victory. You will not understand them if you do not. Therefore I attach very great importance to the candidate for the Army being educated in England. He may go abroad to learn other things, but he should not go abroad for his general education. I set great store about his being brought up at school with other young men with whom he will afterwards be associated in public life, so that he may find himself to a certain extent in touch with them. The importance of this to England is far greater than to any foreign country. Our country is so cosmopolitan; the English Officer is thrown into such a variety of situations abroad where he has to act in ways that do not at all naturally fall into the military line, that it is most desirable that he should have a more general education than would merely qualify him to command a company. This point is one of great importance, and it is therefore, I venture to think, a right policy that we should if possible get our candidates for the Army from the public schools, because we wish to get them with the feelings and training of English gentlemen. The lecturer mentioned the case of the Duke of Wellington, and I wish also to bring him as a witness on my behalf. When he said that the Battle of Waterloo was won on the playing-fields of Eton, he evidently attributed more to Eton education than to education at a military school in France. Nor do we find that the Duke of Wellington was very distinguished in the early part of his career. It was not until long after he commanded a regiment that he became at all distinguished. The fact was that where he learnt his experience was in the school of war. He was a man of great ability and talent, and that was developed on active service. After all, nothing can develop training so well as active service. You cannot produce an Officer by mere school training who would be ready to meet any emergency. They say an ounce of practice is worth a bushel of theory. If you quote the case of Sir Charles Napier as an illustration of one who was entered very early into the military service and who rose to great distinction, I might, on the other hand, mention the case of Lord Lynedoch, who was second to none of those under the Duke of Wellington's command, and who did not enter the Army until after the age of forty. He was a man who, having had the ordinary training of an English gentleman, did not turn his attention to military subjects until after he was forty years of age, but who then developed those qualities which were no doubt inherent in him. It is for that reason that I venture to demur to what has been said by Colonel Graves, because I think it is very important that our young candidates for the Army should come, if possible, from English schools. We are under very great obligation to Army tutors. In the last Report that was issued on Military Education I drew attention to this, and pointed out that it would be most unjust to withhold from them the credit of having shown very successfully how to prepare candidates for the Army examinations. But it is not on that account that I should disagree with public schools. On the contrary,

I should wish the public schools to a certain extent to follow their example. There is a great deal of difficulty in that, and the difficulty is greater than some people suppose. One reason is, no doubt, that the old public schools have such a large *clientèle*, that they are unwilling to meet the wishes of a limited body, as they have plenty of candidates from all classes who are waiting for admission. I was lately speaking to a young fellow in the sixth form of a great public school, and I was asking him about the Army class in that school. At that school they had some very valuable exhibitions which were tenable after they left the school for several years, and one was for mathematics. I said to him, "I suppose the mathematical exhibition is sometimes obtained by a boy on the modern side." "Oh! no," he said, "never." I said "How is that? They have to go especially into mathematics." "Oh!" he said, "they go into mathematics, but only up to a certain point. They only go up to the Woolwich standard; they do not go up any higher." He said the boys who get the exhibitions go higher than that. That is, you see, one of the points which is one great difficulty in regard to competitive examinations. The Army tutors and the public schools say, "You wish us to prepare boys for the Army," and they prepare them up to the point of passing. If they pass, that is sufficient, but they do not care to go one step beyond, because it does not pay. The public schools prepare other boys for the liberal professions generally; they do not wish to prepare them for any special examination, but ground them well so that they may get honours hereafter, and then point to the honours which they gain some years after at the Universities as being to the credit of the school. That is one great difficulty which we find. At the Royal Military Academy the boys are only trained up to the point of passing, and do not go any further. It is a very difficult subject to deal with, and I am bound to admit that I see no way out of it, as long as competitive examinations last; and I do not see any way of doing otherwise than retaining competitive examinations. I believe a much better way of securing candidates for the Army would be to offer cadetships to the sixth-form boys at the public schools. You would by adopting it get a very good class of well-educated young fellows; but it would never be sanctioned. Moreover the pressure to exercise patronage would be most excessive, and therefore I think it is quite out of the question. We are thrown back, therefore, to do the best we can, and I confess, responsible as I have been to some extent for the scope of examination for entrance to the Army for some years, I am prepared to maintain that the present arrangement is the best, and in this I am supported by the Civil Service Commissioners, who, having had great experience in these matters, are entitled to have their opinions duly respected, and I am sure they will always carry weight. I wish to remind you of what was said by a very eminent man in a recent article that was published. I allude to Lord Armstrong, a man who, having begun life as a solicitor's clerk, has ended by becoming one of the richest men in the kingdom, and at the head of an army of 14,000 employés. He said in that article, alluding to the general education of the country: "The present system of primary education has the radical defect of aiming at instruction in knowledge rather than the training of the faculties." That puts into words better than I can do what I am anxious to explain, viz., that the education of a man should not be devoted solely to the acquisition of knowledge; it should be devoted to the training of his mind. You will find that though the man who has been well and thoroughly trained will not appear to go so fast as the specialist at first, yet he will overtake him in the long run, and when he comes up into middle life you will find he is a much more valuable man. I have been very much struck with statesmen and other leading men in this country with whom I have had the good fortune to associate from time to time, to find that in the case of those men who have had the ordinary old education of the public school and university, what a powerful mind they display in dealing with difficult subjects which are entirely new to them. They have such a power of seeing the point at issue. Whatever fault may be imputed to our statesmen, few will deny that they do as a class display an extraordinary power of grappling with the very difficult subjects they have to deal with. I attribute that to the thoroughness of their education in the training of their faculties. I am afraid I am rather transgressing the limits of your time,

and therefore I must not keep you too long. There have been some remarks made by Captain James, and I am sorry he did not remain here to hear what I have to say about them. He made some very stringent remarks about the examiners not having their names published beforehand. Now I think anybody who will consider that subject will see that there is a great deal to be said against it, indeed, more than there is to be said in favour of it. He began by saying that there is no public body in England that does not have the names of the examiners published. I think it would be difficult to prove that it is not the other way. The Civil Service Commissioners are the very largest body of public examiners in this country, and they do not publish the examiners' names on the papers. I believe they did so at one time, but they found it so objectionable that they were forced to withdraw it. Captain James says the examiners cannot be got at; it was for that very reason that it was withdrawn, because when the examiner's name was published, his life was a burden to him. He received letters from mothers and fathers of candidates imploring him not to pluck their sons. It was such a state of things that no examiner in the world could put up with. Even in these days I have had complaints made by examiners of remarks being made by the candidates at the end of their examination papers, such as, "Please be as favourable as you can; this is my last shot." If such a candidate had passed, I think it would have been a question whether he would not have been disqualified for attempting to exercise an improper influence on the examiner. But the examiners are not unknown. In the periodical reports from the Military Education Department the names of the examiners are given in full, with the subjects which they examine upon, so that people are able to judge whether proper examiners have been selected. The Civil Service Commissioners follow the same rule; they publish the examiner's name and the subjects he examines in, and people can then judge whether a proper man has been selected for the subject. Dealing with the former part of the paper, as to Colonel Graves comparing the Army with the Navy, we must not forget that the Navy is a very special service. If men do not begin very young in the Navy they are not likely to come to that efficiency which we expect in our naval Officers, and they do the same for their sailors, that is to say, they deal with boys, and a very large number of them. Few people would say that it is equally desirable that young gentlemen should be trained in camps from an early age with all the surroundings of garrisons or camps in order to make them thoroughly acquainted with military subjects. There is no comparison between the two things. The Navy have another great advantage, that they are always, as it were, on active service. When our sentries walk up and down their only object is to take care that they see the "visiting rounds" as soon as possible. The sailor, on the other hand, has to be on the look-out for all sorts of contingencies; he has to look out for rocks; he has to look out for ships, boats, or anything that may happen; in fact, he is always on active service. That is the great advantage that the Navy has. We cannot compare the two Services in any sense. I only wish it were possible that the Army should have similar training, but that training can only be got at the seat of war, because you cannot possibly get people to take the same interest they would do if their lives were at stake. There is another point I should like to mention. Colonel Graves spoke about the number of candidates for Woolwich and Sandhurst. The actual number for Sandhurst at the last examination was 590 for 121 vacancies, rather less than 5 to 1. The average for the last three years has been a little over 3½ candidates for every vacancy, and for the six years before that rather less than 3½ for every vacancy offered. Those are the exact numbers.

The CHAIRMAN: How is it at Woolwich?

Sir R. BIDDULPH: The proportion there is about two to one. I think I have now trespassed too much on your time. I will only express my thanks to the lecturer for the trouble he has taken in dealing with this subject.

Major-General J. KEITH FRASER, C.M.G.: I fear it is rather presumptuous in me to speak on this subject immediately after the gallant General, with whose opinions about public school education without any technical instruction for boys intended for the Army, I am afraid to differ. The gallant General himself, I think, has shown proof of the advantage of technical military education. Unfortunately no such opportunities came in my way. I can only speak of my own experience.

I was at a public school, the public school indeed of which the Duke of Wellington is said to have spoken so highly. When I left that public school I knew very little indeed which has been of the slightest use to me as a soldier ever since. I learned no French nor any living language, and I learned no arithmetic. I certainly did not learn to read or write. I learned indeed how not to write through having to do many written punishments. In those days we had to set ourselves, after leaving a public school, to the study of foreign languages abroad, and to spend most of our later lives in trying to educate ourselves in matters which we ought to have learnt before entering the Army. Before that, and for many generations, I do not think the English Officer, under that system, was a very uneducated man. I think the higher ranks of the Army held many very highly educated men. The Duke of Wellington had under him men who spoke foreign languages, and men who were great military scholars, not only Lord Lynedoch, who has been mentioned by Sir R. Biddulph, but others—General Craufurd, who was no inefficient General. He could speak French and German, and was indeed a past-master in these languages. He studied the art of war in Germany under Frederick the Great. The fact was Officers had to teach themselves, as men do now who have been at our public schools, after leaving them, in all matters connected with their profession. It has been my deep regret all my life that I had not had any military education. I am not one of those parents who make up their minds late what their sons are going to be. I always meant my boys to be soldiers, and I sent them to public schools thinking that was the right thing to do, and that in these later days they would learn something useful. I sent one to a public school, at the laying of the foundation stone of which I had been present, immediately after the Crimean War, when we were all very keen about military education. I thought that school had been established as one where boys would be taught military matters, and would learn everything necessary in the way of a good military education, and be able to follow the footsteps of the great General whose name that school bore. I sent my boy there with that firm belief, and I must say I am very grateful to the school for two things: he was taught to swim and he was taught to fence, both excellent things in their way; but as far as military education was concerned, I do not think he knew anything until he went to those much-abused gentlemen, who I have been very pleased to hear praised to-day, I mean to the "crammers," men who know what to teach and how to teach it. I only wish that such men taught at our public schools. As to foreign languages, I do not think they are taught for any practical use at public schools. There is only one other matter I should like to speak upon, that is, about the standard of education required of non-commissioned officers. I do not think that a very high education is an absolute necessity for a non-commissioned officer. I think if he has a simple general, combined with a thoroughly good technical, education, that is sufficient. We must not put education too high. In foreign countries, a non-commissioned officer is a man who has great technical knowledge; he must know all his duties thoroughly, but he does not have to pass stiff examinations late in life. The reason which Sir Robert Biddulph has given for the necessity of gentlemen having a good general education, namely, that they come into contact with statesmen and others, does not certainly apply to non-commissioned officers. I do not think it is necessary for non-commissioned officers who have very trying duties to perform, with perhaps hardly a minute to spare in the day, that they should pass very high examinations in history, in geography, and those sort of things. A non-commissioned officer, say, a cavalry sergeant-major, has very hard work to perform. He may know his duties admirably well; he may look after men and horses most efficiently; and every one of us knows that a sergeant-major who does his duty has very little time to himself, and that even if there is a school to the barracks, which there is not in many cases unfortunately now, he has not much time to educate himself; but in order to pass an examination for promotion he has to know about things such as the "Self-denying Ordinance," the "Act of Supremacy," the "River System of Africa," and he has to answer those sort of questions before he can be a regimental sergeant-major. Now I do not think a regimental sergeant-major need know anything at all about the river system of Africa or the Act of Supremacy, and in no army in the world but ours would such knowledge be required. I wish, indeed,

we had less of these educational examinations. It very often happens that a man may be thoroughly efficient in every way, but ignorance of such subjects as those I have mentioned just prevents him from getting to the top of the tree. I have an instance in my mind of the best man who could possibly be found for a very high position, a man, in fact, who had done the duties during the absence and illness of the holder of the appointment for a long time, but he was passed over because he had not a first-class certificate. He had no school to go to, and certainly no time to go to one even if he had had one. It was far too late in life—he was thirty-eight years of age—to commence learning about English history, the geography of the world, &c. I only wish to say these few words. I do not think a high-class education or stiff examination are everything for a soldier, and I only wish before an Officer came into the Army that he could learn something of his profession. I do not think an Officer should be put to try to teach his men if he has to learn it all himself, perhaps from them, as is generally the case now.

Lieutenant-Colonel E. GUNTER: We are, I think, very much indebted to Colonel Graves for the admirable lecture he has given us, and for drawing attention to this most important subject. As a special Army tutor, I beg to thank him for the courteous way in which he has spoken of our efforts, and Sir Robert Biddulph and the Officers for having kindly recognized them. As regards the question of special or general education for the Army, I agree with Sir R. Biddulph, that a good general education is what is wanted, but I think early training is necessary, and one point ought to be particularly attended to by schools preparing young men for the Army, that is, closer training in mathematics. I do not speak of higher mathematics, but more thorough training in arithmetic, algebra, &c. Unless these things are thoroughly taught in the first instance, it becomes a matter of difficulty later on. Officers are frequently called on in the course of their duties to make accurate and rapid calculations, and unless they are early trained to habits of accuracy, their after-education is impeded. With regard to some of the points touched on by Captain James, I agree with him that there should be only one text-book as the authority on fortification, and as Chatham is the seat of learning of that branch, it seems natural that the book in use there should be the one. I hope the Director-General will permit me to allude to the necessity for a new synopsis for Sandhurst, and for the Militia competitive. The present one has been a very long time in existence. It is very desirable that the exact subjects on which the examination will be held be made known, so that the training of Officers be thoroughly carried out. As regards the education of Officers in the Army, I agree with all that Colonel Graves has said. I think the fact that Captain James alluded to of your Officers coming up in much fewer numbers for coaching for promotion, is a good deal to be attributed to the garrison instruction classes. Colonel Graves recommended towards the end of his lecture that special classes should be held at garrison centres for the instruction of non-commissioned officers. The Director-General of Military Education has not lost sight of this point, for these classes have been held by Garrison Instructors (now D.A.A.G. for Instruction) since 1884. There were twelve non-commissioned officers of cavalry and infantry, and they were put through exactly such a course as Colonel Graves recommends. The course lasted one month (I think it now lasts six weeks), and the results, especially as regards cavalry non-commissioned officers, were most satisfactory. The men took the greatest interest in the work, and, I have no doubt, it has borne fruit. Further, the whole of the non-commissioned officers and company Officers of the infantry in garrison were put through a regular course of field works to assist them in their "military training" by two companies at a time, the Garrison Instructor giving them first a day's instruction indoors, by lectures and models, and afterwards five hours' practical instruction outside. Afterwards, that is, later in the year, they were put through a higher course of practical field works, under the Commanding Royal Engineer. I think, therefore, progress has been made in that direction.

Commander SULLIVAN: As I think I am about the only naval Officer present, I rise to say I feel very proud of the way in which the Navy has been spoken of, and I hope we shall always deserve the high opinion expressed. With regard to what has been said in the course of the discussion, as to taking all the military Officers from sixth-form boys, I do not think a Naval Officer would have very

much chance in general of getting any of his sons into the Army if that were to be the qualification, for few would have money enough to keep them at a public school until they got up to the sixth form. Therefore that might be rather a drawback to the proposal, from a naval point of view.

The CHAIRMAN (General Clive): Following the rules of this Institution, I will make a few remarks, and then Colonel Graves will reply. The discussion has been interesting. Captain James has replied for the Army tutors, and Sir Robert Biddulph has traversed the whole ground and has given exactly the reasons that have actuated the Director-General's Department in the course they have taken; and Major Watson has answered for the engineers. Colonel Graves wishes to devise a system of education which (1) shall enable boys to get into the Army without changing their place of education; and (2) shall be advantageous to them when they are serving. He has therefore so divided his recommendations. It seems to me that no system of education can possibly be devised which will answer the first of these requirements, unless all educational establishments make entrance into the Army their first object. The difficulty of getting into the Army is not caused by the want of a sound education, which can be got at any public school, but results from the competition of candidates, under which 75 per cent. of those who compete are unsuccessful. The changes, therefore, suggested by Colonel Graves will not answer their object, because, however military and sound the public school education becomes, if one out of four boys only is wanted, and if he be selected by examination, there will always be special instruction provided by other tutors, to whom ultimately the candidates will turn to improve their chances of success. What causes this extravagant competition? The professions in this country for a young gentleman are limited in number. A father who wants to choose a profession for his son has only certain choices to select from. Colonel Graves has alluded to the greater efficiency of Naval to Army Officers in professional knowledge. I quite agree with him, but thinks that this is due to the different conditions of the Service. But it is too late to enter the Navy. The father must, therefore, either put his son into business, which is expensive—or into Orders, or to the Bar, medical profession, or make him an engineer. The boy probably does not want to be a doctor or to take Orders; the Bar, though it possesses distinction and prizes, is overstocked, and the result is there is nothing left except the Army. What then are the advantages the Army gives? I am trying to point out what causes the difficulty, the extravagant competition. In the Army as soon as a young fellow joins his regiment, whatever his character or disposition may be, whether surly or bad tempered, whether he has social or other virtues, immediately he puts on Her Majesty's uniform, he is considered to be a gentleman—he can go where he likes, do what he likes; he is welcomed wherever he goes; he sees the world; and with reasonable good health and chance of promotion he can finish with a pension of 420*l.* a year. I will ask any gentleman here, whether father of a family or not, does he know any other profession in which you can show as good a result for a pleasant life? That is the reason everybody crowds into the Army. For Sandhurst we have 500 or 600 candidates—100 or 120 to be selected. For these we may demand certain conditions in height, health, and character. If the successful candidate is to be a good Officer he should have good decision, common sense, nerve, and talent. Now comes the question of his education for the Army: Colonel Graves wants the boy to begin early, at fourteen, to learn fortification, mathematics, military work, &c., while Sir Robert Biddulph says "Give him a general education." Now I agree with Sir Robert Biddulph. If you look at the ordinary duties of an English gentleman's life, public or private, a good public school education is the most suitable, as it is for the Army if he can get into it. I believe that, at Sandhurst, where I have the honour to serve now, we are perfectly able to give that boy so good an education that when he joins his battalion he will be able to take to his duty. We cannot make him love reading, but we can teach him what he is to read and give him the rudiments of what he will have to learn. Of course it stands to reason during the short time that boys reside at Sandhurst, the military practical education cannot be very thorough except for gifted lads; but such as are likely to be good at topography, or at field fortification, or good at tactics or law, have plenty of opportunity for

success. Next term we shall have residence prolonged to 1½ years for all Cadets, and when they join their regiments I quite expect the Colonels will say that they are suitable young fellows for them. I believe the Colonels of regiments will bear me out in saying that the kind of boy they want to join their regiment is a fellow good at athletics, sharp, smart, and who has been at a public school. Therefore, I prefer the present system. I do not think it will be worth while for me to go into the Staff College course now. The conditions of the Staff College education make it most difficult to become a course which shall be suitable to Officers from different branches of the Service, with widely varying attainments, who have to undergo an uniform course which closes with a qualifying examination, whereas they entered under a competitive examination. I believe we are all trying to do the best for the Service. I believe the most suitable man for the British Army Officer is he who is healthy, strong, who can ride, who has got nerve and decision and common sense, and who is fond of sport. We can teach him well enough what he will want to know on joining, and when he joins his regiment I am satisfied that Colonel Graves, or any other Commanding Officer who follows on Colonel Graves' lines, will do the rest for him.

Colonel GRAVES (in reply): I must not keep you long: two or three words will suffice. Major Watson, speaking of what I said with reference to the School of Military Engineering, complained that I did not give the whole of the subjects that the young gentlemen were put through. Well, that may be, but what I want to emphasize with reference to this establishment and work is that their method is a singular exception to the methods and systems of every other branch of the Service in this, that they are without examinations to test the knowledge gained at the end of their long course of two years. That Major Watson has not denied. Further, that they send their Officers there immediately after joining. In my paper I asked the question, "Is it wise so to do?" I am still of the opinion that it is not wise. The engineer Officer has had a very trying time at school preparing for the competitive examinations at the Academy. He has had a very hard time at the Academy, striving to get into the first few on the list passing out, so as to ensure getting into the engineers; and forthwith, after so doing, he is sent straight away to school again, to go through a very drastic course indeed at Chatham, and I am in possession of letters from Officers of experience in the engineers now serving at Chatham, taking a totally different view from that expressed by Major Watson here to-day. I do not think it is wise to send these boys there so early, and I would emphasize the fact that it is not so in the Line; it is not so in the artillery. And in reference to India, the Government insist on engineer Officers going through another instructional course on professional subjects before they get permanent employment in that country. Of course Major Watson would not have been worth a button in building a fort if he was sent straight away without going through that course, but the authorities would have no business to send a boy under such circumstances. All the more fools the authorities if they did so. I do not think his argument with reference to that touched the point at issue. With regard to the remarks of Sir Robert Biddulph and the Chairman touching the public schools, I cannot help—if I may with great diffidence put it before you—I cannot help feeling that when you bring statesmen into the question, and where you quote them as examples for a certain line of action, you, I would respectfully submit, are arguing from the exception to the general rule, which, I think, is not the wise course to pursue. I maintain most distinctly and dogmatically that it was the utter weakness and utter failure of our public schools to finish off the education of the young candidate for the Army that brought this host of Army tutors into existence. Let me argue *ad hoc*. I maintain as strongly and as dogmatically that if the public schools will finish off their own candidates for the Army, then the Army tutor may die a natural death. The Army tutor need have no status whatever if the public schools will teach their boys properly and put them into the Services themselves. It is a fact which is beyond controversy that hundreds of boys are taken from our public schools year by year and sent to Army tutors because the public schools do not give the necessary finishing touches to their education. Sir Robert Biddulph said, if the education of the boy is made special to the Army at a very early age he loses many

advantages. I agree with Sir Robert Biddulph up to a certain point. That a general education is necessary as a foundation, that a classical education is necessary as a foundation to modern languages, everyone knows, and so on, and I nowhere advocated the teaching of military subjects only. But the point I wish to put clearly is this, that the naval Officer who has had a very early education for his profession is not thereby made, if I have understood Sir Robert Biddulph aright when speaking of military Officers, incapable of leading men afterwards. Again, as by his very early education he has not been disqualified from associating with those of equal rank and birth in the life that he himself comes from,—for I maintain that our naval Officers are acceptable in every port in the world wherever they go, and are always more popular than those of any other service in the world,—I maintain that the education of their early youth has not in any way militated against their polish as gentlemen and against their social position afterwards.

Sir ROBERT BIDDULPH: I must protest against having been supposed to say anything to suggest that. I have so many friends in the Navy!

Colonel GRAVES: The point was, I think I am right in saying, that in the Army——

Sir ROBERT BIDDULPH: I did not say a word with reference to the Navy about that, about the boys being trained up apart from other boys. I left it quite open.

Colonel GRAVES: I know you did not; but I think you said if the Army candidate was so trained, it would have the result that they would not be fit for society, &c.

Sir ROBERT BIDDULPH: No.

Colonel GRAVES: I am very glad. I think there was an impression in the meeting, as well as in my own mind, that that was rather intended. I maintain that early military education need not separate Officers socially from the statesmen of the future that may be at school with them any more than in the case of naval men. There is nothing more for me to say with reference to the criticism that has been offered. I agree most firmly with Sir Robert Biddulph and with our Chairman, that we should get our candidates from the public schools. I believe the boy at the public school is a better boy in many ways, both socially and from the athletic point of view, and from general largeness of mind and idea, than the boy who has been brought up in a cramped sphere. But there can be such a thing as a model school, and I believe our public schools should be arranged to meet the special purposes in life of the pupils, and should train the boys from early youth on those lines, without their being separated from those who will afterwards be statesmen, and so losing something in the way of social power and influence.

The CHAIRMAN: I think we may propose a vote of thanks to Colonel Graves for his interesting lecture and the discussion to which it has led.

Wednesday, May 11, 1892.

ADMIRAL OF THE FLEET SIR GEOFFREY T. PHIPPS HORNBY, G.C.B., First and Principal Naval Aide-de-Camp to the Queen, and Vice-Patron of the Institution, in the Chair.

THE PLACE AND USES OF TORPEDO-BOATS IN WAR.

By W. LAIRD CLOWES, Gold Medallist and Hon. Life Member of the United States Naval Institute.

SOME months ago, in this Theatre, I heard a verbal invitation conveyed to an Officer to read a paper here on the subject of torpedo-boat warfare. As that Officer is not only a recognized expert in that branch of naval theory, but also a Gold Medallist of this Institution, I allowed myself to hope that he would see his way to doing as he had been asked; and for some weeks I looked forward to seeing in the papers an announcement of the title and date of his lecture. To my great regret I did not see it. Instead, I was myself honoured with an invitation from the Council to read a paper on "The Place and Uses of Torpedo-boats in War," and although I am very deeply conscious of my lack of competency for the task, I am so sensible of the importance of the subject, so desirous of seeing professional attention drawn to it, and so anxious to hear it fully discussed by those who are best qualified to discuss it, that I gratefully agreed to do my best. The action of the Council in thus requesting a layman to place his views and theories before them is, believe me, a compliment which I thoroughly appreciate.

Before I go any further, I feel that I ought to explain my position here; for no sooner had this lecture been announced than Admiral Long asked me, "Where did you graduate in torpedo-boat warfare?" And, no doubt, the query that occurred to the late Commodore of the "Red" Squadron must have since occurred to others. Well, I have tried to read everything that has been written on the subject; and I have tried to see everything that has been to be seen in connection with the subject, since the year 1885, when, as a passenger in the great fleet which was then commanded by Sir Geoffrey Hornby, I first witnessed something of the behaviour of torpedo-boats at sea. Since that year I have been provided with very numerous opportunities, not only for going to sea to watch torpedo-boats, but also for going to sea in torpedo-boats, in all kinds of weathers, in all types of boats, and in

several different parts of the world. I have been in them during trial trips and during manœuvres, by night and by day, and under several flags. I have been in torpedo-boats when attacking ships, and in ships when attacked by torpedo-boats. And thus I have managed to acquire certain views which, I may fairly claim, are based upon experience. But I have, I think, derived even more advantage from conversation and correspondence with Officers who have had experience in this most interesting branch of their profession. And here I should like to remark that neither in our own nor in any foreign service does it seem to me that there is a more able, enthusiastic, scientific, keen, and devoted class of young Officers than the class which specially busies itself with torpedo work; and that, although I have seen much of the striking ability, resource, and keenness of American, German, and Austrian torpedo Officers, I believe most sincerely that in no Officer-like qualities are our own torpedo Officers excelled.

In thinking over my subject, I have become aware that it is one which has a peculiar tendency to grow to very wide and—for the purposes of a lecture here—unmanageable proportions; and I have therefore come to the conclusion that I must limit it as much as possible. I do not, in consequence, purpose to touch upon such questions as "What is the proper building policy for this country to pursue with regard to torpedo-boats?" or "How shall we find men of the sort requisite for efficient torpedo-boat service?" or "What is the best defensive policy for a fleet or a ship in presence of, or threatened by, torpedo-boats?" These are, I dare say, fit subjects for special lectures; but if I ventured to touch them, I should not have time in which to deal with even the fringe of my own proper subject, "The Place and Uses of Torpedo-boats in War." In one direction only do I purpose to allow that subject to extend itself. In considering the conduct of torpedo-boats in war, I cannot altogether refuse to consider the question of their conduct in peace; for I think that I am entitled to assume that, until a place and a use for torpedo-boats shall have been discovered and experimented with in peace-time, torpedo-boats must be comparatively useless for the operations of war.

I am going to take it for granted that we have the best torpedo-boats that we can obtain, and that we have them at our command in peace-time. Typical of the best boats are the new 130-foot craft (Nos. 82–87), which were supplied a couple of years ago by Mr. Yarrow to the British Admiralty, and which have an extreme speed of 22·5 knots; the new Elbing boats, Nos. 75 and 81–96, which have been ordered by Germany, and which have an extreme speed of 26 knots; the new 24- and 25-knot boats of Messrs. Thornycroft, of Chiswick; the new 25-knot French boats; the boats which Mr. Yarrow has built for the Argentine Government, and which have an extreme speed, with a 14-ton load on board, of 24·45 knots; and lastly, the proposed 160-foot Yarrow boat with which, so Mr. Yarrow tells me, a speed of 27 knots, with a load of, say, 25 tons, can be promised. I premise the same thing with regard to torpedo-gun-vessels, viz., that we

have the best that can be built. So long as it was supposed that the excessive vibration of fast craft was in some way due to excessive lightness of scantling, we could not reasonably expect torpedo-gun-vessels in smooth water to be quite as rapid as 1st class torpedo-boats which have, proportionately, smaller weights to carry. But since Mr. Yarrow has demonstrated, as he did in his interesting paper read last month before the Institution of Naval Architects, that we must attribute vibration not so much to lightness of structure as to ill balancing of engines, and since he has shown how to overcome that difficulty, we may hope to have torpedo-gun-vessels able, even in the smoothest water, to steam as fast as all but the very fastest class of torpedo-boats, and easily able to beat, in a slight sea, any torpedo-boat that has yet been designed. Writing to me, Mr. Yarrow says: "How much speed can be got in a torpedo-gun-vessel of 1,000 tons displacement will depend entirely upon what is sacrificed to speed, seeing that everything is a compromise, and that all depends upon the value that is attached to the various qualities of coal-carrying capacity, weight of armament, weight of machinery, weight of hull, &c. But I certainly do not at all see why, with due regard to other qualities, speed, say, of 23 or 24 knots should not be obtained. This I feel as sure of as I can be sure of anything." Having made these preliminary remarks, there is nothing, I think, to take me again from my proper subject. Much of what I shall say is taken from my paper contributed to the April part of the Proceedings of the United States Naval Institute.

In the early days of torpedo-boats, these craft were regarded as proper companions for a fleet at sea. In 1885, with the Particular Service Squadron, there were six of the 87-foot, and two of the 113-foot boats, each one being attached, during the greater part of the manœuvres, to a big ship, and drawing from her the needful supplies of coal, water, food, and stores. I believe it is admitted that at sea these boats were failures. They could sometimes make so little progress that they delayed even ships that had a sea speed not exceeding 10 knots; they were a continuous source of trouble and anxiety, and they were abodes of misery to those who were in them. So wearying and exhausting, indeed, were they to their companies that, had it been a case of real instead of sham warfare, I doubt whether the people would have remained physically capable of displaying that extraordinary watchfulness and nerve without which torpedo-boat warfare can never be successfully conducted.

On the 9th and 10th of June, while steaming at a very easy speed on a calm sea, three of them broke down. On July 11th, off the north-west coast of Ireland, in a brisk breeze from the westward, the senior Officer in charge of four of the boats had to request permission to take them all in shore. And on July 17th and 18th, during half a gale in the Irish Sea, some of the boats behaved so badly that their crews, able neither to eat nor to sleep, and overtaken by most alarming sickness, were completely worn out and prostrated. What was attempted by England in 1885 was attempted by France in 1886, and in the following years by both nations. The British, having

found that their 113-foot boats were not sea-keepers, tried 125-foot, 127½-foot, and 130-foot boats. The French tried an even greater number of types, ending with the 151-foot boats of the "Ouragan" class. But long before the series of experiments had been carried far, it was pretty generally recognized that the torpedo-boat, as distinct from the torpedo-boat catcher or torpedo-gunboat, was unsuited for keeping the sea; and that if sea-keeping torpedo-vessels were required, they must be of 250 tons displacement at least, and might, with advantage to the comfort and condition of their crews, be considerably larger. This conclusion had the effect of creating a new species of small craft, midway between the torpedo-cruiser and the torpedo-boat. To the new craft, the torpedo-gun-vessel, has been assigned most of the work which it was originally supposed the torpedo-boat was capable of; and the torpedo-boat, being no longer needed to serve as a scout and dispatch vessel, fell into some neglect until her merits and her potentialities were developed in a new direction, first, to a slight extent, by the Germans, and then, especially during the Naval Manœuvres of 1890, by the British.

What may be called the new view of the proper functions of the torpedo-boat regards that little craft as merely a quick and decisive raider from a base, and not as a vessel from which any kind of sustained effort must be demanded. The torpedo-boat's business is to strike like a bolt from the blue in the most unexpected quarters; to be always in perfect readiness for a few hours of rough hard work under extreme pressure; to appear unannounced in distant places; to vanish unpursued and unseen; and never to expose herself unnecessarily either to the violence of the sea or to the attention of the enemy. I don't want to trouble you with the history of recent naval manœuvres, British and foreign, or with that of the attack on, and sinking of, the Chilian Congressionalist ironclad "Blanco Encalada" last year. I assume that all this is fresh in the minds of most of you. To my mind all the facts that we have concerning the employment of torpedo-boats either in peace or war tell in favour of the principles which I have just briefly enunciated, viz., that the torpedo-boat must be regarded not as a sea-keeper, but as a dealer of sudden and unexpected blows. Neither must she be looked upon as a craft suited for an action of the ordinary kind. During the Chilian troubles the Congressionalist armed transport "Aconcagua" easily beat off the torpedo-gun-vessels "Almirante Lynch" and "Almirante Condell," which, as regards gun power, are of course much more formidable than any mere torpedo-boat can hope to be, and seriously damaged one of them. These craft committed the error of looking upon themselves for the time being as firers of shells instead of as firers of torpedoes; and I imagine that the experiment which they tried was so conclusive as to prevent in the future any torpedo-vessel from deliberately seeking an encounter, upon equal terms and in daylight, with a vessel tolerably well armed with machine and quick-firing guns.

Secrecy and suddenness, then, are desiderata of prime importance for the success of a torpedo attack. Equally important are organiza-

tion and training. The descent upon the Fleet at Plymouth in 1890 was made with sufficient secrecy and suddenness; but neither the organization of the flotilla nor the training of the ships' companies engaged was what it should have been. An Officer who took part in the affair lamented to me that Lieutenant Sturdee's division of six boats was too large to admit of being properly kept in hand by a single Commander; and another Officer informed me that many of the Lieutenants in command of boats had gone on board without proper instruments for the navigation of their craft in case of the separation of the flotilla; that the engine-room complements were not familiar with the machinery; and that the discharge of the torpedoes took place in some cases with undue haste and flurry. These were the naturally resultant faults of incomplete organization and training. Similar causes led, no doubt, to the large number of failures to run during the British manœuvres of 1891, and to the numerous misses and failures of the Chilian war. One has heard of torpedoes having been fired before they have been tested for floatability, and even before they have been charged with air; and I myself have seen a torpedo picked up with its water-tripper jammed in such a way that it could not possibly have acted. Accidents, oversights, and follies may always occur in connection with operations like those which are now under consideration; but system will reduce to a minimum the liability to any of these, and I shall now endeavour to suggest a system of organization, training, and war tactics which appears to be logically suggested by the experience of the past.

In order to be able in war-time to properly utilize torpedo-boats for a descent such as was made upon Plymouth in 1890, a naval Power should, I am convinced, keep the greater part of its torpedo flotilla perpetually in commission. I do not mean that each boat, where there are considerable numbers of boats, need be kept in full commission with, as in the British Navy, her Lieutenant, one or two Sub-Lieutenants, and a gunner or boatswain on board. But the engine-room staff, since it can never know too much about the boilers and machinery, should be always attached to the craft, and should be given frequent opportunities of perfecting acquaintance with its delicacies and its peculiarities. The executive and navigating staff require no such special and intimate knowledge. One torpedo-boat may be navigated and fought very much like another. Her idiosyncrasies—or, at least, her important ones—reside entirely in her boilers and machinery. While, therefore, each boat, if she is to be employed to the greatest advantage, must have an engine-room staff that is thoroughly accustomed to her, any competent navigator or any competent executive Officer would serve almost as well as one who had been born and bred on board. It would be enough, in ordinary peace-time, to place a trustworthy Warrant Officer in charge, and to leave him there as Second or Third Officer upon the full commissioning of the boat for manœuvres or war.

But a single boat should never, for any purposes, be regarded as an independent unit. What the unit in torpedo warfare should be is still a matter of discussion. In infantry tactics the battalion is the

unit; in artillery tactics it is the battery; in torpedo-boat tactics it must be the division; but battalions and batteries are not in all armies of the same strength, nor even in particular armies are they always invariable; and the same is the case with torpedo-boat divisions. The German division, for example, consists of six 1st-class boats and a "division boat"—a vessel of 300 or 400 tons displacement, of great speed, and of characteristics generally resembling those of the *avisos-torpilleurs* of the French Navy, or of the "torpedo-gun-vessels" of the British. In England the division has contained six, four, or three boats, with or without a torpedo-gun-vessel attached. In France also the constitution of the division varies, or has varied. Professional opinion now, however, seems to incline in most countries in the direction of the division of three boats, with, if possible, a larger craft to carry the Divisional Commander, to lead the navigation, to undertake the repair of small defects, to provide supplies of water, coal, and stores, and, in short, to act for brief periods as a small *mère cigogne* to her consorts. Where three boats to the division are not advocated, two appear to meet with more favour than four, and four with more favour than five or any greater number. British Officers of experience almost with one accord advocate three, with a larger craft; and I shall confine myself to the consideration of the division as thus constituted, for I believe it to be far and away the best.

The peace "state" of such a division would include a full complement for the larger craft (which would be commanded by a Lieutenant, with a Lieutenant for navigating duties, a Sub-Lieutenant, a Chief Engineer, a Surgeon, and subordinate Officers under him), and reduced complements (consisting only of a Warrant Officer and engine-room staff) for each of the three boats. The Divisional Commander would thus have at his disposal sufficient Officers and men to enable him to keep his division in good order and training, and to continually exercise part of it along the coast in the neighbourhood of his headquarters. But he should by no means be the sole director of its operations. An Officer of superior rank (a Commander or Captain) should be appointed to a small cruiser as Inspecting Officer, and should be empowered and required to visit all divisional headquarters unannounced, and, by day or night, to mobilize the divisions, manning them up to full war complement from the ship's company of his own vessel, and then exercising them at manœuvres at full speed. If, for example, a division had its headquarters at Portland, an Inspecting Officer arriving there unannounced by night would teach valuable experience to the command by mobilizing it, and despatching it in all haste to Guernsey or Penzance and back. The celerity, ease, and absence of mishaps with which the operation should be carried out would to a large extent measure the efficiency of the division for the kind of work to which it would be put in war-time.

And here I may fitly state some of the arguments in favour of adding a "division boat" or torpedo-gun-vessel to each division. Every one who has had much experience at sea in torpedo-boats knows how

very limited is the horizon from the low deck of so small a craft, and how difficult, especially in bad weather, is the navigation of her. A vessel with a mast of some kind, and with a proportionately wider horizon, can keep a far better look-out than any torpedo-boat, and so avoid dangers that the torpedo-boat may easily fail to discover until she is close upon them. Again, the larger vessel, being roomier and steadier, can take observations and conduct navigation with much greater facility than the smaller one, and may, in fact, "make" the navigation for her consorts when they cannot readily make it for themselves. But this is by no means all. The inevitable delicacy of torpedo-boats renders them particularly liable to slight, but not insignificant, damage by collision and other accidents. A "division boat" can carry appliances for the remedy of innumerable small defects either in hull or in machinery. She can also tow a more seriously injured craft; render effective help to the crew of a foundering one; serve as hospital to her division; make a lee for the protection of her consorts; shield them until the critical moment from the observation of a careless enemy; cover them with her guns; and render them a thousand small offices of value, besides inspiring them generally with confidence.

So numerous are the advantages attendant upon the action of some kind of a division boat with the division, that, in my humble opinion, a division should never venture far without having one either with it or close at hand. But such co-operation may, of course, be at times impossible, owing to scarcity of vessels or to the inability of division-boats to leave blockaded or narrowly-watched ports; and even in the best provided country there may be a local, where there is by no means a general, scarcity of torpedo-craft, for it is easy to conceive of any given port being so carefully guarded as to render it hopeless for any regular torpedo-flotilla to issue from it with the object of attempting a sudden blow. Single vessels might escape and take refuge temporarily along the coast until they saw their opportunity to strike, but they might be unable to arrange any combined attack and might be reduced to operating independently. This would deprive them of much of their value; and, therefore, I confidently anticipate that in the next war, wherever it may occur, means will be devised to facilitate the concentration and combined action of torpedo-boats in spite of any system of observation or actual blockade that may be established by the enemy.

Devices of this kind would not facilitate the co-operation of division-boats, save in countries which are exceptionally well provided with a network of canals of some depth; but they might, in all civilized countries, ensure the complete mobility of torpedo-boats not exceeding about 50 tons displacement, and they might, moreover, enable the blockading fleet to be effectively attacked from the most unexpected quarter, namely, from seaward.

In 1887 experiments were made in France to test the transportability of torpedo-boats by railway. The first-class torpedo-boat, No. 71, was sent overland from Toulon to Cherbourg in August of that year. The special train which carried it consisted of three

carriages, two freight cars for the armament, two more freight cars for the stores and gear, and a series of specially-constructed trucks for the boat itself. The boat measured 108 feet long, 10 feet 8 inches broad, and 9 feet deep, and, at the time of transit, weighed 38 tons. It reached Cherbourg in four days, but it did not travel by night; and so it may be assumed that, had promptness been necessary, it could have covered the distance of about 700 miles in 48 hours, or less. The cost of the single experiment was at the time stated to be but 1,400*l*. In the total, the expenses of the specially-built trucks was, of course, a very large item. A full account of this interesting experiment will be found in the "Marine Rundschau" for April, 1892.

What could be done in France could be done with even greater facility in Great Britain. Boats blockaded, or watched, say at Portsmouth, could, in a very short space of time, be transported by rail to Bognor, on the one hand, or Swanage on the other, or even to much more remote places, whence, having awaited a favourable chance, they might operate with deadly effect, and probably with comparatively small risk, upon the rear of the hostile fleet. The only special appliances that would be requisite would be the trucks, and at each end of the distance a short branch line of rails running from the existing railway into the sea. The trucks could be built in three days; the branch lines could be laid in as many hours.

Probably no attack would have better prospects of success than one conducted in this way; for it might be made from any one of a hundred different quarters, and it would be obviously impossible for any fleet to watch all the points from which the boats might be launched upon their mission. But the case which I have imagined is an extreme one. Effective blockades are growing every day more and more difficult. In August, 1888, I was with the squadron consisting of the British vessels "Warspite," "Iris," and "Severn," which, without being observed, and with the greatest possible ease, escaped from Bantry Bay, in spite of the attempted blockade of the comparatively narrow-mouthed haven by seven battleships, seven cruisers, and six torpedo-boats. Save in the face of perfectly overwhelming outside force, a well-handled torpedo-flotilla, constituted either as a division or otherwise, should always be able to operate from a port like Portsmouth or Plymouth, and to strike with the requisite suddenness. It would be from more open ports, or from ports with only one narrow entrance, that effective surprises would be really difficult.

And this leads me to the consideration of the three kinds of torpedo-boat attacks which seem to be permissible in the warfare of the future. These are:

a. Attacks from a base against an observing or blockading force that is close at hand.

b. Attacks against fleets or single ships cruising at sea at a distance.

c. Attacks against fleets or single ships at anchor, close at hand, or at a distance.

Attacks from a Base against an Observing or Blockading Force that

is Close at Hand.—This is the form of attack in which the co-operation of the division boat may, with the least disadvantage, be dispensed with. The approximate position and strength of the enemy are known. The superior horizon of the division boat is, therefore, not required; neither is that craft likely to be so urgently needed to serve as a magazine, store-ship, and refuge for the division, as in the case of operations conducted from a distant base. I do not think that the number of vessels constituting the hostile force should influence the number of torpedo-boats to be employed. French tacticians have suggested that in the attack at least three boats should be devoted to each ironclad; but I would use not more than three boats in any attack, whether against a single ironclad or against a whole squadron. A greater number cannot easily be controlled by a single directing intelligence upon the spot; and if I had at my disposal more boats than three, I would utilize them, not in one solitary onslaught, but in a succession of attacks, by divisions of two or three boats operating from different quarters, at times laid down beforehand by a superior authority on shore. An attack in numbers would inevitably lead to confusion, and probably to collision and damage; and for this reason I would not allow even a division of three boats to attack simultaneously *en masse*. The whole secret of success in torpedo warfare must lie in the wise utilization of those moral effects which are produced upon nearly all men by the unexpected, the terrible, and the vague; and in order to utilize these to the greatest advantage, my boats, as well as my divisions, should go into action successively. One would be naturally tempted to select for attack the leading or rearmost ship of the enemy. To choose the centre vessels of a column would be to expose the boats to a concentrated fire from several craft. On the other hand, the leading and rearmost ships, realizing their relatively exposed position, would be apt to be keeping a better look-out, and to be more prepared than the others. On the whole, therefore, I am inclined to think that the best procedure is to adopt such tactics, by way of commencement, as will disorganize the enemy's preconceived ideas, and to then act as prudence and the situation may have suggested.

And here I would say one serious word which applies to all torpedo attacks. Every contingency must be arranged and provided for beforehand. When the undertaking has once been begun, the time for revision of schemes has passed away. In presence of an enemy, torpedo-boats cannot signal to one another without danger of betraying themselves; and they must, therefore, be prepared to do without signalling. But this does not, of course, imply that a single cast-iron plan must be adopted and rigidly adhered to. Alternatives may, without difficulty, be prearranged, and their adoption may be made to depend upon the condition of the sea, or of the light, or upon the motions of the foe. But it must be remembered that the slightest glimmer from a lantern, the striking of a match, or the weakest suspicion of flame above the top of a funnel may render abortive all attempts at surprise.

A fleet engaged in blockading or watching a port may be disposed

in any one of a hundred different ways, and is almost certain to be at night in a formation different from that which it maintains by day. But it should nearly always be possible to ascertain something of its habits. There will probably be an inshore squadron of light craft and cruisers, while outside will be the battleships and other heavy vessels. The quarry should, of course, be the heavy vessels; and the initial problem for the attack is how to avoid the cruisers. The problem almost solves itself if the idea of transporting the boats by railway to some unsuspected and unwatched base be made use of. If that project be impracticable, the boats must feel their way out as best they can; but those boats which are to immediately co-operate must, at all hazards, keep together until they have passed the inshore squadron. I mean that if one division only be employed, it must not, on any excuse, separate until it is quite certain that the whole of it has got through, and is available for the prearranged work. If two or more divisions be employed, each may go out independently; but the second must not start until it knows that the first has escaped, nor must the third go until the second is safe; for, just as boats 1, 2, and 3 of each division are dependent, No. 2 upon No. 1, and No. 3 upon No. 2, so are squadrons 1, 2, and 3 of the whole force. It will not be of great importance to division No. 1 to know that division No. 2 is out; but it will be of the highest importance to division No. 2 to know that division No. 1 is in a position to do its share towards preparing the way for No. 2's attack.

If the outgoing boats be fired upon, they should not return the fire, or even hesitate in their attempt, so long as there remains the remotest possibility that they are not clearly seen and recognized. Experience shows that cruisers often fire at things which exist only in the imagination of some excitable man. I well recollect that in 1888, upon the occasion of the escape from Bantry Bay, there was a great deal of firing from the blockading force, and that we all believed that we had been observed. It appeared afterwards, however, that we had not been seen at all, and that the firing had been directed, either at an imaginary target or at some of our consorts which, though not trying to escape, were making a diversion in our favour. Nor need the outgoing boats necessarily lose heart if the search lights of their opponents be flashed right upon them. In 1888 a search light from the "Hotspur" was flashed along the whole length of the escaping "Severn," at a distance of not more than two or three cables (for we could distinctly see the people around the projector), yet by some chance the "Severn" was not discovered. But, of course, should there be no doubt that the attempt has been fully detected before a blow can be dealt, there should be a retreat. An axiom of torpedo-warfare is that, save perhaps where mere picket boats and launches are her opponents, the torpedo-boat must avoid being attacked and being provoked to fire until she is endeavouring to use her torpedoes. And another axiom is that she must not employ torpedoes as weapons of defence against casual foes, but must reserve them for employment as weapons of offence against the main enemy. Her proper defence is evasion and ultimately flight.

In addition to the position and formation of the enemy, the wind deserves the attentive consideration of the attacking Commander. Approach from leeward, especially when the wind is on the beam of the ships to be attacked, seems, upon the whole, to hold out the greatest promise of success; for the smoke of the ships' guns, when they open, while sufficient to obscure the boats from the ships, will not be sufficient to obscure the ships from the boats. If there be no wind, an attack is certainly best made from seaward, firstly, because that is the quarter which is regarded with least suspicion, and secondly, because the boat, having attacked and discharged her torpedoes, need not lose time and incur risk while turning under fire, but may run straight past the enemy back to port. But special circumstances must regulate the interpretation of all general rules. Where the coast is bold, and the depth of water has invited the enemy to cruise close in, it may be found wise to make the attack from under cover of the shadows of the land. In such shadows, both where there is no moon and when the moon is low down over the land, a torpedo-boat can only with the utmost difficulty be detected. It was by taking advantage of the land shadows that the boats of the Blue Squadron were able to approach the Red Squadron at anchor in Luce Bay on the morning of July 26, during the manœuvres of 1891. I was watching for them with an excellent night glass: but while in the shadow they were absolutely invisible, although they were less than half a mile away, and although the night was by no means a very dark one. I do not desire to advocate the making of the attack from any particular quarter, so much as to dwell upon the necessity for well organizing it beforehand, and upon the advisability of prefacing the real attack with one or two feints from a different direction.

On the eve of an attack, the boats to be employed should test all their torpedoes, both as to immersion, and as to the working of the machinery. The weapons should then be freshly charged, and finally everything should be formally and severely inspected by a responsible and specially qualified executive Officer, accompanied by an engineer assistant. The inspection should take cognizance of Officers, men, armament, engines, charts, instruments, &c., down to the smallest detail; and, the general plan of attack having been decided upon, all possible contingencies must be provided for. The main object to be attained is that at the specified hour for the commencement of the action, all boats shall be in their prearranged position, and that each Commander shall know what every other is going to do, and when he is going to do it, and also what he himself has to do, and at what moment. All is to tend to the due carrying out of successive single concerted feints and attacks, which have been prearranged and set down with the conciseness and accuracy of the entries in a railway time-bill.

The chief cautions to be observed, so far as experience causes them to occur to me, are, that boats should never expose themselves longer than is absolutely necessary, and should, as quickly as possible, withdraw out of sight, and then rapidly shift position, so as to

appear next time from a new quarter. Haste and excitement must be studiously repressed by the Officers, who should themselves discharge the torpedoes from distances never exceeding one cable. In returning to port after action, boats must throw off the rule of secrecy, and, in some unmistakable manner, announce their approach to their friends, signalling also whether or not they are pursued. If this precaution be not taken, the returning boats will certainly be fired upon. Sir George Tryon's well-known maxim is, "In war-time, if you see a torpedo-boat, fire at her without waiting to ask questions;" and, in offering this advice, the gallant Admiral is fully justified by all that has been seen of torpedo-boat work in the past. I think, however, that if returning boats made use of some very conspicuous rocket signal—each boat having her own for that particular night only—no risk would be run by not firing at her. On the other hand, if there be the slightest doubt about the craft, she must be attacked as she comes in. Wherever it may be feasible, I should advise that boats do not return to port until daylight, and, in the meantime, take refuge in some unwatched cove, or lie to where they are out of danger. It would, indeed, be a misfortune if boats, after having done good work outside, should come back to be sunk by their friends. But the risk is a very real one. Every recent series of manœuvres in England, France, and Germany has exemplified it.

Attacks against Fleets or Single Ships Cruising at Sea at a Distance.—In this kind of attack, the division boats may play an exceedingly important part. They can save their division from much useless wear and tear and exhaustion at sea, and can enable them to go fresh into action. The torpedo-boats themselves are, as has been said, not fit to attempt to keep the sea. If they do so, they do it at the expense of the nerve and physique of their Officers and men. But the division boats can keep the sea without danger of this kind, and it is therefore an unfair test of the capabilities of a torpedo flotilla to send it, as was done during the manœuvres of 1891, to worry and attack a sea-going fleet, and to deprive it of the co-operation of torpedo-gun-vessels. It is equivalent to sending a battleship fleet to sea without cruisers.

When one talks of torpedo attacks against ships at sea at a distance, one speaks, of course, relatively. No one dreams of attacking in this way a fleet in mid-Atlantic, or even 500 miles from shore. But a fleet operating, for example, in the Adriatic, in the English Channel, in the Irish Sea, among the West India Islands, or within, say, 300 miles of any coast-line, would be susceptible of attack by an enemy possessed of a shore base within range. That base need not be one prepared beforehand. Only a safe and unobtrusive haven for torpedo-boats is needed, and any retired little bay with a sufficiency of water, and not too difficult an entrance, will serve admirably.

From this base, having first seen her smaller consorts snugly anchored in it, the division boat issues. If there be two division boats, so much the better. They go forth alone, and, at 18 or 19 knots speed, they scour the seas in search of the enemy. Having found him, they follow him a little so as to discover, if possible, his intentions, and

then send or take back information to the base. If they be near a friendly coast, they telegraph the information from the next point, and order a rendezvous. If they cannot telegraph, one of them must go back with the news; but as the division boat would be able to cover about 150 miles in eight hours, and as a fleet, unless pressed, does not do much more than half the distance in the same period, the loss of time, though regrettable, is not particularly serious. Upon receiving the information, the torpedo-boats make the best of their way to the rendezvous. This brings them somewhere into the neighbourhood of the fleet. They pick up their division boats and follow the quarry, taking care, however, to keep well away from his cruisers by daylight. At night, an attack, arranged very much as in the case of an attack upon a blockading fleet, is made, the division boats covering their divisions as much as possible, and then standing by, either to attack meddlesome cruisers or to render help to their divisions in case of need. I do not think that they should approach ironclads unnecessarily, for they are comparatively large targets, and big shells bursting in them may easily be fatal; but I think that they may advantageously interfere to harass, and take off the attention of the enemy's scouts; and, if one of these should be a a little rash or unwary, there may be an opportunity of torpedoing her.

Before every attack, a rendezvous for each division should, of course, be arranged. If there be more than one division, the two points of rendezvous should be well out of sight, but not too far distant, one from the other.

Once more a series of successive single concerted feints and attacks, directed according to plans as prearranged, seems to promise the best chance of success. I desire, however, to call attention to some of the relative advantages and disadvantages of attacks from ahead and attacks from astern upon a fleet under steam; since a consideration of these may influence a Divisional Commander in his choice of the quarter whence he will attack most seriously.

The economical steaming speed for most large ships is about 10 knots. This is the speed at which a squadron would be likely to cruise in war-time, unless it were engaged upon some pressing duty; and it is a speed which is roughly equal to 17 feet a second. The attacking speed of torpedo-boats ought to be at least 18 knots. This is a speed equal to over 30 feet a second. On a moderately dark night, a torpedo-boat approaching is not much exposed to detection by the look-outs in a battleship so long as she is at a greater distance than 2,000 yards. She may, of course, be prevented by cruisers and light craft from approaching even so near as that; but, for the purpose in hand, I will assume that she is not. The range at which, with reasonably favourable prospects, she may discharge her torpedoes at a moving mark in a sea-way, does not probably much exceed 150 yards. It becomes, therefore, in the highest degree important to her to traverse in as brief a period as possible what I may call the Helpless Zone—the zone I mean, in which, although she may be discovered and fired at, she cannot effectively attack in return. She will

naturally traverse it most quickly if she approach from ahead on the line of the enemy's course.

In the case of vessels having the speeds given above, viz., 17 feet per second for the ship and 30 feet per second for the torpedo-boat, the times occupied by the latter in traversing the Helpless Zone of 1,850 yards (5,550 feet), are :—

If attacking from right astern	7 mins. 7 secs.
If attacking from right ahead.....	1 min. 58 secs.
Balance in favour of attack from ahead	5 mins. 9 secs.

Seeing that so long as she remains in the Helpless Zone, a torpedo-boat is liable to be struck and damaged, or sunk, without being able to do the work upon which she is employed, this reduction of the period of exposure deserves serious attention. What it means may be illustrated by a moment's consideration of the enormous number of projectiles which a modern vessel can launch at an opponent in the space of a single minute of time. Many a battleship of recent construction can bring to bear right ahead or right astern two heavy guns, six quick-firing guns, and six machine-guns, or revolving cannon. Leaving the heavy guns aside, the quick-firing guns could, in a minute, fire 8, and the machine-guns 200 projectiles apiece. This, from such a battleship as I have in my mind, would give a total of 1,248 projectiles of sorts per minute. Surely it cannot be a matter of indifference to the Commander of a torpedo-boat whether he run the gauntlet of about 2,470 projectiles or of about 8,750. Nor is this all. The slower the approach of the boat, the greater will be the accuracy of fire ; and the more prolonged the exposure, the more will that accuracy of fire increase. In addition, and this is very important, a torpedo discharged from the boat coming down ahead will near the ship much more rapidly than one discharged from a boat following astern, and will afford proportionately less opportunity to the enemy to outmanœuvre it. But, although I would attract notice to this, I do not wish to be understood to imply that any torpedo ought to be discharged from right ahead or right astern. A torpedo discharged from right astern is liable to be deflected by the wash from the ship's screws, and has, moreover, but a small target; and a torpedo discharged from right ahead has not only a still smaller target, but has also to contend with the ship's bow-wave, which is very likely to deflect the weapon harmlessly astern. The proper position from which to discharge the torpedo from a boat coming from ahead seems to me to be broad-on the ship's bow ; and, from one coming from astern, broad-on the ship's beam. In each case I would prefer to use broadside rather than bow tubes ; for bow tubes, when boats are running at high speed, often act most unsatisfactorily. Many authorities advocate that an effort should be made to hit the enemy in the neighbourhood of his screws and rudder ; but experience seems to show that if you can fairly explode your torpedo anywhere against his side you will do him all the damage that is necessary ; and, undoubtedly, if you aim at him amidships you

are less likely to miss him than if you aim at his counter. If you succeed in disabling him in any way his next astern may complete your work by running him down in the confusion.

I have dwelt somewhat upon this question of the direction of the main attack, because, although it is quite obvious that, at least in some respects the attack from ahead is much less risky than the attack from astern, nearly all the attacks which I have seen made during manœuvres upon ships under way have, strange to say, been executed by boats coming up from astern. This attack will always, I suspect, be the favourite one in peace manœuvres, because, for various reasons, it is in peace-time the easier to attempt. It may also be the fact that vessels habitually keep a worse look-out astern than ahead. But I do not think that it will be the favourite mode in actual war; for it bids fair to be too costly in men and material, owing to the relatively long exposure in the Helpless Zone. The attack from ahead was not attempted at all during the British manœuvres of 1891. Two torpedoes only were aimed at ships under way, and both of these were discharged from boats approaching from astern; and all the threatened attacks came from the same quarter.

How to get safely out of action will be almost as difficult a problem as how to get safely in; but nothing more generally wise can be counselled than for the boat, which has already swerved a point or two in order to bring herself on to the bow or quarter of her opponent, to complete a turn of eight points if there be a second ship in the line, and to get away as fast as she can, showing her stern to the enemy's broadside, and so affording as small a mark as possible. If, before doing so, she can discharge a second torpedo, so much the better; but when withdrawing she must not lose sight of the probability that she will encounter a cruiser or be pursued by one; and, therefore, as soon as she is out of the zone of immediate danger she should sharply alter her course for the quarter which seems to promise her the greatest security. It may appear inhumane to say so; but I cannot convince myself that a torpedo-boat, having sunk her enemy, should stand by to assist the survivors. Her crew is obviously too small to resist an attempt made by numbers and desperation to seize her, and she has no accommodation for prisoners. When there is no second ship, the best course is for the torpedo-boat to maintain her original direction. Using the helm involves delay, no matter how handy the boat may be, and should, when practicable, be avoided. Not far away the boat should be able to rejoin her division, and with it she would be comparatively safe.

Attacks against Fleets or Single Ships at Anchor, Close at Hand or at a Distance.—I regard this as the least promising mode of attacking ironclads by means of torpedo-boats; for all modern ironclads have, or may have, torpedo-nets; and vessels properly commanded and possessed of nets would not fail to get them out immediately after anchoring in war-time. It is true that Captain A. K. Wilson, V.C., R.N., has invented a species of shears which, fitted to the head of a torpedo, will enable it, provided all goes favourably, to cut through

some existing nets; but it is equally true that the invention, though ingenious, has only a limited practical value, because nets strong enough to defeat it could be easily carried, even if it were all that it is intended to be. But certain vessels do not, and are not likely to, carry nets; and these, especially if they can be thoroughly surprised, may be attacked at anchor with good results. It may also be sometimes worth while to descend upon battleships immediately after they have anchored, in reasonable expectation of finding that they have not had time to get their nets out. As a rule, however, battleships will in war-time get their nets out and in very quickly. I hear of ships in the Mediterranean which, when first commissioned, could not execute either manœuvre in less than three hours, but which can now do either in ten minutes. Commanders should, therefore, turn their attention to inducing hostile men-of-war at anchor with nets out to take their nets in and, if possible, to making them also get under way. This they may sometimes do,—particularly when the vessels are lying elsewhere than under forts,—by obtaining the temporary co-operation of battleships of their own. Ships in unfortified havens will remain doggedly anchored when threatened by torpedo-boats, but not when threatened by craft of their own class; and when, in deference to a feint by battleships, they weigh, the torpedo-boats may dash in and find their opportunity. When an attack is made, the same considerations should guide it as should guide other attacks. Surprise, efficiency of men, machinery and weapons, and concerted action are all-important factors in the success of the undertaking; and if the attack can be delivered from the most unexpected quarter,—which in this case is the direction of the shore,—it will have the best chance of doing well.

It is claimed for some of the most modern marks of the Whitehead torpedo that, if they hit a net fairly and squarely when running at full speed, they will penetrate it. This may be so. If they explode in contact with it, they will certainly demolish great part of it, no matter how it may be boomed out; and therefore it may occasionally be worth while to organize a torpedo attack with a view to first destroying the nets and then the ships; but this seems to me to be a risky and precarious device, and one which should not be attempted where there is a possibility that other methods may, within a reasonable time, become practicable.

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So much for those forms of attack which seem to be permissible.

The attacks which, in my humble view, are not permissible are attacks by daylight, and attacks during actions wherein two fleets are engaged. Concerning the almost absolute hopelessness of success by daylight against any respectable enemy I need, I think, say nothing. But it is necessary to say a word concerning attacks during actions wherein two fleets are engaged: firstly, because French tacticians notoriously believe them to be practicable, and secondly, because at least one very distinguished British naval Officer may be suspected of holding the same opinion.

The tactical unit of the French Fleet consists to-day of a division commanded by a Rear-Admiral, and consisting of three ironclads, three cruisers, and three torpedo-boats. This unit was adopted a few years ago, and was deliberately readopted for the manœuvres of 1891. And in his recently published book on "The Development of Navies," Captain S. M. Eardley-Wilmot, R.N., criticizing the battle of Lissa, says:—

"One thing is wanting to complete the valuable experience gained on that day and make it applicable to the present time. No locomotive torpedoes were used, this arm as a naval weapon not having been then introduced. Whether, after the line was broken and the ships were all mixed up together, it would not have been as dangerous to friend as to foe may well be questioned; but small vessels specially armed in this way would have had good opportunities of gliding in under cover of the smoke and dealing deadly blows to partially disabled ships."

The objections to the use of torpedo-boats in fleet actions are twofold. If they be used in fleet actions, they must, of course, accompany fleets to sea, and, whenever they have hitherto done so, the inconvenience of the plan has been abundantly apparent. They cannot in bad weather keep up with 10-knot battleships: they are perpetually in distress, and their crews get worn out and incapable of energetic action. Lieutenant Charles C. Rogers, U.S. Navy, in his summary of, and comments on, the naval manœuvres of 1890 ("General Information Series," No. X, Office of Naval Intelligence), says of the French operations: "The battleships and cruisers behaved well at sea, but the torpedo and dispatch vessels were a source of anxiety. Several times the battleships were obliged to take some of them in tow; the manœuvres seem to prove that they have not sufficient endurance. Their very powerful and complicated engines are in small and light hulls; and in continued bad weather, which occurred during the later manœuvres, the personnel gave out constantly." And in his report on the French Manœuvres of 1891 ("Marine Rundschau," November, 1891), Kapitän-Lieutenant von Klein, of the German Navy, remarks of the torpedo-boats: "These, which, with their superiority of speed, were intended to attack the enemy during the night, experienced trouble and discomfort in keeping up with B squadron at 10 knots. Those of A squadron, the ships of which steamed at 12 knots, were absolutely unable to preserve station, and had to be sent away to await better weather." This observant Officer, in summarizing the lessons of the operations, suggests that they indicate that the proper functions of torpedo-boats are not understood in France, and that such craft should be entirely restricted to service as part of the mobile coast defences. With this last suggestion I do not, however, believe that British Officers will entirely agree.

The other great objection to the employment of torpedo-boats in fleet actions has been hinted at by Captain Eardley-Wilmot, and is, I am sure, a very real one. The boats would be as dangerous to friend as to foe. At Plymouth, during our manœuvres of 1890, No. 86's

torpedo, intended for the "Black Prince," apparently hit the "Anson," and No. 59's torpedo, intended for the "Northumberland," hit No. 51; while in 1891, No. 42's torpedo, aimed at the "Hotspur," struck the nets of the "Northampton." In both these British manœuvres also, quite a number of torpedoes, that had missed their mark, were wandering about after almost every attack. The same thing happened at the attack on the "Blanco Encalada"; and it is probable that something similar will happen in the case of every attack. What, then, would happen to two fleets of ironclads mixed up in action with two flotillas of torpedo-boats? The answer seems to me to be tolerably obvious.

But there is a mission for small torpedo-boats accompanying large ships to sea, and acting from them as from a mobile base. The torpedo-depôt ship "Vulcan"—a comparative failure, I admit, yet the representative of a type which may easily be improved—carries six of Yarrow's 60-feet 16-knot boats; and these, dropped into a comparatively smooth sea, within a reasonable distance of a hostile squadron, might, in certain circumstances, do very useful work. A land base is, however, always much superior to a floating one. It admits of larger and faster boats being employed; it gives the boats far better shelter; it involves much less wear and tear of material; and, in brief, it is above comparison with the other, which is, at best, a *pis-aller*. A "Vulcan," caught in daylight by a couple of fast ironclads, with her flotilla waiting around her to be hoisted inboard, would not be in an enviable position. A good land base, containing an equal number of torpedo-boats, would be vastly safer, and could be easily rendered so strong as to be perfectly secure, unless forces were landed to co-operate against it.

The French and Italian Governments have adopted the principle of establishing "nests," or small military harbours, for torpedo-boats, around their coasts. This seems to be an unwise proceeding. A "nest," the existence of which is perfectly well known, can be guarded against, and easily attacked. An impromptu "nest," on the other hand, can be quickly created, almost anywhere, on a deeply-indented coast; may be quite as serviceable as a permanent one; and may, for a considerable period, exist in war-time unknown to the enemy. A permanent "nest," moreover, must be in some way protected by expensive works or by mines, while an impromptu "nest" may be, for a time at least, protected by the secrecy with which it has been formed. Stores and provisions for torpedo-boats can quickly and easily be sent to any point of a civilized country by rail, and it is almost as convenient for the boats to take them on board at one place as at another. Therefore, I would strongly advocate impromptu, as opposed to permanent, torpedo-boat stations, in war-time. The former conduce to mobility; the latter really tend to restrict it; and it is the mobility, within, say, a distance of 200 miles of your coast-line, of your torpedo-flotilla that, more than anything else, measures its utility. With a sufficient, efficient, and completely mobile torpedo-flotilla on its coast-line, a country should be able for a long time to keep any maritime enemy at a very

respectful distance, and to strike anything venturing within 200 miles. Permanent stations are well enough in peace-time; in war-time the first step should be to abandon them in favour of impromptu ones.

It has often been debated whether or not the search light should be employed by torpedo-boats in the attack. My experience indicates that generally it should not. Silence, darkness, secrecy: all these are, as a rule, favourable to the boats, and they cannot be, as a rule, too carefully observed. But when an approaching torpedo-boat, which has been seen and fired at, discovers that the enemy has got her range and is doing her damage, she may, I am convinced, often save herself by boldly flashing her light full in the eyes of the gunners. I saw a case in 1891 in which, after the light had been so used, the range of the boat seemed to be entirely lost. The use of search lights, and especially of search lights against search lights, is a subject which has not yet been sufficiently studied. As at present advised, I would prefer to dispense with it on ordinary occasions of defence, as well as of attack. It exercises a prejudicial and very varying effect upon the eyesight at the time as well as subsequently; and, while it may make valuable revelations, it may also make dangerous betrayals. But the subject is too wide a one to be here entered upon.

For the numerous failures of torpedoes to hit their target, and even to run at all, I think the human element is more to blame than the mechanical. Familiarity with the weapons on the part of those who have to use them will, as training improves, reduce these failures to a minimum; and the weapons themselves have now reached so great a degree of perfection that they leave very little to be desired. I do not mean that it is impossible to conceive a better automobile torpedo than the latest mark of Whitehead; but I do mean that the Whitehead seems to have very nearly exhausted such improvements as can be made in it, and that at present, although it has some inherent and inevitable defects, it is, upon the whole, better than any other torpedo.

Captain S. M. Eardley-Wilmot, R.N.: I have observed that whenever a paper is read in this Institution, especially if it is a paper on a naval subject, there is always great reluctance on the part of those who know most about the subject to rise and start the discussion. As I cannot claim myself to know very much about it, I shall plunge fearlessly into the fray in the hope that some who do know or have had very much more practical experience in the handling of torpedo-boats will follow, to give us their valuable experience. The author prefaced his paper with some remarks with regard to an explanation of his meaning and qualification to deal with the subject. If anything in the nature of an apology were needed, and I do not myself think such a thing was required, I think he has thoroughly proved his capability of dealing with the subject, and has given us a paper full of most interesting matter, and it seems to me that a paper of this sort has been very much needed for a considerable period of time. Various opinions have existed as to the place and use of torpedo-boats in war, and as Mr. Laird Clowes justly remarked in his paper, views have changed. Regarded originally solely as weapons of defence, torpedo-boats are now looked upon as weapons of offence, striking sudden and unexpected blows from distant bases. I should like first of all to point out the great value of the torpedo-boat as a defensive weapon. A torpedo-boat, carrying a very powerful torpedo, may be viewed from the point of view of the defence as a submarine mine with power of locomotion. The great point about a submarine mine is that, once fixed, it is immovable, but a torpedo-boat

can shift its position from one point to another; and in some harbours of dual entrance it is a great thing that you can move your torpedo-boat from one entrance to another, whichever may be threatened. A submarine mine has not this faculty, and the result is you require an enormous number of submarine mines. Very much the same argument is applicable to forts and ships. A ship is a fort with the power of shifting its place when required. Then, again, a torpedo-boat may be viewed as a controlled torpedo, such as we have seen in the type of the Sims-Edison and the Brennan, and with a much greater radius of action. Therefore, we should not altogether neglect its great capabilities as a defensive weapon. We have had some very interesting information as to the power of the torpedo-boat to effect its attacks upon squadrons in various ports in distant places. We must, however, I think, recollect that in our manœuvres the torpedo-boats have a great advantage which they would not have in war; that is to say, they start to make their attack under conditions, knowing the position and composition and general equipment of the squadron which they are to attack, which I do not think they would have in time of war. That is a very important point, that in these manœuvres the torpedo-boat flotilla, ably conducted as it was, had the advantage of knowing that the enemy's squadron was at anchor in a certain port, that it was composed of a certain number of ships, and that if the torpedo-boats started at a certain time and kept up a certain speed, they would arrive at the place where the squadron was, before daylight. That seems to me a very important point, and therefore when we are called upon to discuss the best conditions in which to attack a ship, whether we should attack her from ahead or astern, and so forth, I say the position from which you will attack will entirely depend upon the position of the ship, because you may find, when you come to the position in which she is, that you may not be able to attack from any position you like. Of course, no Officer would attack the bow or the stern of a ship—a limited target of 60 feet—if he could get a shot at the beam, which is a target about eight times as long. That would entirely depend upon where the torpedo-boats might find the squadron when they arrived at the place where they expected to see it. The same thing applies as regards the effect of torpedo-boats upon a blockading squadron. The author has put forward a very excellent idea, that a torpedo-boat may be transported across the country, launched at some distant place, and then proceed to attack a blockading squadron from the rear. Now, it has been assumed, I think rather hastily, that the action of a blockading squadron is almost entirely nullified, if not made very much more difficult, by the action of torpedo-boats; but I cannot myself say that that would be the case. The blockading squadron is not obliged to lie close into the blockaded port; in the old days it was seldom that the main bulk of the squadron lay close in; it used to be 20 or 30 miles off, with its inlying craft at a much closer distance. In the same way, at the present time, we shall place the main bulk of the blockading squadron 20 or 30 miles off, with small craft lying inside ready to grapple with the torpedo-boats when they come out. Consequently, supposing the torpedo-boats did manage to get through, they would find the blockading squadron, which would not be in sight, might be in any part of the distant seas, and if the blockading squadron changed its position every night, giving notice of that to its satellites, the torpedo-boats that had got through the inshore squadron would have to find the outer squadron, and might spend pretty nearly the whole of the night before they did so. Therefore, I do not see that the work of the blockading squadron is made impossible by the existence of torpedo-boats. Then I notice the author of the paper made a remark about nets, in which he said they only had a very limited value, because, although torpedoes at the present time had special apparatus for cutting through nets, it was very easy to make the nets heavier and stronger so as to keep out the torpedoes. It is the old story of guns *versus* armour. It is very much easier to make the torpedo heavier and swifter, and so to overcome that, than it is to go on increasing the weight of the net. Consequently, I look for the time when we shall practically almost have to give up that. I think the torpedo, like the gun, will beat the net. The writer of the paper was kind enough to allude to some remarks I made in my book upon the "Development of Navies," in reference to the action at Lissa, and he inferred from those remarks that I was speaking about what might have been

the action of torpedo-boats supposing they had existed at that time. But, as a matter of fact, what I had in my mind was not torpedo-boats, but those torpedo-gun-boats such as the "Rattlesnake," and I think when the vessels of the two squadrons have got to close quarters, such vessels of 600 or 700 tons might, under the cover of the smoke, glide in and deal very severe blows without extraordinary risk to themselves. It was not a question of torpedo-boats. I quite agree with the lecturer when he says that a torpedo-boat should not be looked upon as a portion of a sea-going fleet, although I think there is a tendency rather to make too much about the hardships and impossibilities of existence on torpedo-boats, because last year when the French squadron arrived at Portsmouth Harbour they had two torpedo-boats accompanying them, which the Admiral stated had been with him for six months, and had been served all through the cruize by the same Officers and men, and that he found, after the first month or two, they had gradually accustomed themselves to the life, and what they can do, no doubt we shall do. No doubt, in first going on board, as, in fact, going to sea, there is sickness and discomfort, but, after a time, you become inured to it the same as to anything else, and, if it was necessary, no doubt we could do it. But the great difficulty about torpedo-boats accompanying a squadron is that they cannot keep the same speed, as it was said a short time ago by the Director of Naval Construction, in an interesting paper, that the larger the ship so much easier is maintenance of speed. Therefore, we have always endeavoured to get something larger than torpedo-boats as sea-going vessels. We have our examples in the "Rattlesnake" and her consorts. I think the lecturer is very right and forcible in what he says with regard to the matter of organization, that you cannot use torpedo-boats effectively unless they are organized, and frequently practised throughout the year. We should always have a flotilla of torpedo-boats in commission, not only for exercise in their own particular work, but also as training ships, and admirable training ships, both for Officers and men. That is carried out to a much greater extent in foreign navies than in our own. In the Baltic it is something wonderful to see the amount of training and exercise that is carried on during the year in torpedo-boats. I rather take exception to what the lecturer said when he stated that nobody except stokers and engineers could go on board torpedo-boats, and navigate and operate in them. I think only those who have had considerable experience in torpedo-boats——

Mr. LAIRD CLOWES: You misapprehend me there. I meant that there is no necessity for them to be in that particular boat, but there is for the engineers to be kept in their particular boat, on account of the difference in the engines.

Captain EARDLEY-WILMOT: I beg your pardon. That, I think, is a very great point. I do think we want more organization in our torpedo-boats. Of course when you hear people comparing the number of torpedo-boats of one country with another there is no reason at all in that. One country may want 6 and another 600. It is entirely a matter of the extent of coast, the number of harbours and ports that have to be protected. I will not detain you any longer, because, no doubt, you are anxious to hear those who have had more experience than I have. At the same time I must say I think we have had a most interesting lecture, bristling with points for discussion, so that it is very difficult to know what to pick out and what to leave alone.

Admiral LONG: As Mr. Laird Clowes has alluded to a little joke which I addressed to him on a former occasion, I feel bound to endeavour to make some remarks on the paper. "The place and uses of torpedo-boats in war" is a very suggestive title, and as regards the place, I think one may say that in proportion as the hostile coasts are contiguous, or as trade routes approach hostile coasts, so the torpedo-boats become more important. There is one point that has not yet been alluded to, that is, the time a boat must take to return to the position from which it is expected to act. If we take a night of fourteen hours' duration, and credit the boats with a speed of 20 knots, that is 280 miles. If the boat is to go out and come back again without being captured in the face of a Navy possessing preponderance at sea, it must not go more than 140 miles, so that, roughly speaking, I think we may say the place of torpedo-boats in war will be where the coasts are not removed from each other or from hostile trade routes more than 140 miles.

Of course the other point, about 2nd class torpedo-boats acting from a depôt ship, is a very important one, and a very good one, but that mode of attack would probably be more open to use by the Power possessing the supremacy of the sea than it would by any other Power. What is most interesting to England is probably the sphere of action of torpedo-boats as against her. There is another important point as to the place in which torpedo-boats would come in. Certainly in those places where the water is generally smooth, for when the water becomes rough the torpedo-boat is at a great disadvantage; her movements are much more conspicuous, and her speed is diminished, so that that zone which Mr. Laird Clowes has so well described as the "helpless zone" is very largely increased. As regards the time when the torpedo-boat would be of use, I think we are most of us agreed that the night is the time when it will find its sphere of action. In the day-time, I agree with Mr. Laird Clowes that the torpedo-boats, unless they are in very great numbers, are not likely to exercise any decided effect. Of course, like the charge of Balaclava, it is possible to imagine a great number of torpedo-boats incurring most frightful risks, and a great many of them being destroyed, and yet a few of them coming home. That would always be a thing the possibility of which ought to be kept in mind. I think the point which Mr. Laird Clowes puts, that torpedo-boats are now generally considered as only suitable to act from shore bases, is in the main undoubtedly correct, and what would be called the proper function of torpedo-boats. With regard to the uses of torpedo-boats in war, their particular use no doubt will be from ports which are subject to blockade; but although I do not think they will prevent blockade, I do think they will render it far more difficult than formerly to reconnoitre a port and to ascertain what ships are there. They will come in very formidably there. No doubt they will also come in as a most formidable offensive weapon, as Captain Eardley-Wilmot put it. They will be launched like hornets direct at the enemy, and no doubt successive groups of them will be going about in all directions. Though Mr. Laird Clowes has not said anything in his paper as to the expediency of building torpedo-boats or the policy that should be pursued, I think on general grounds it must be said as a matter of common sense that a nation which aspires to the supremacy of the sea must take care to be supreme in all the weapons which will be used at sea. Otherwise I think that nation which neglects any particular weapon on the ground that that is not the weapon they are going to use, but something else, as we have no experience of actual warfare, may possibly find themselves mistaken. It is not right to risk anything on such an argument as that. I agree generally with the lecturer in his tactics about attacking from ahead. As mentioned, in the manœuvres last year no attack took place from ahead. I have had a conversation with the Officer of the attacking squadron, and he said, as he was not allowed to torpedo the scout leading the battle-ships, he attacked the sternmost battle-ship. In real war he would first torpedo the scout and then the battle-ship. I mention this to show the view taken by the Officer himself. I think there is no doubt that a ship that leaves a port at a salient point will be less easy of attack by torpedo-boats than one quitting a port situated in a re-entering angle towards the land, such as Liverpool. Torpedo-boats would have greater advantages in the latter case. They would know the course that the ship would take, and if there were a number of torpedo-boats, it is highly probable they would destroy her. There is one point that Mr. Laird Clowes has not alluded to, which is the very great difficulty which must exist in identifying ships at night. It seems it will be hardly possible for torpedo-boats in an open channel, open to vessels of all nations, to avoid making mistakes on a point of that kind, and I think in one of the lectures to be discussed next week a remark is made as to whether torpedo-boats are to torpedo merchant vessels. We should not lose sight of this problem, for it seems to me that it will be one of the great difficulties with torpedo-boats in war. It is a difficulty that does not occur in manœuvres at all, but in war undoubtedly it will be one of the great difficulties. A torpedo-boat making its presence known becomes liable to be destroyed, and if a torpedo-boat does not do so, it incurs a very serious risk of torpedoing a neutral or friendly ship. I do not think there is anything else I can say with advantage, especially as I know there are Officers here very much more competent to deal with this subject. I am very much obliged to Mr. Laird Clowes for his valuable paper.

Vice-Admiral Sir NOWELL SALMON, V.C., K.C.B.: On the subject of the lecture in general I will not venture to remark. I look upon it that Mr. Laird Clowes has laid down a number of postulates which we are none of us prepared to controvert in any way. He has, however, barely touched upon the point of the use of electric lights as against torpedo-boats. I may claim to have had some little experience of it, both in attack and defence. I have tried it under different circumstances, and have endeavoured to make up my mind whether we should use the electric light or not, and am inclined to think I would rather not have it at all. On any occasion that I have seen, whether it has been at a fixed station on shore or whether it has been a fixed station on board, making a quadrangle within which ships may lie, the torpedo station has always been the point of attack and has always suffered. In one case in which I put a squadron inside four ships to make a path of light round them, the ships showing the light were, of course, at once the point of attack and were all attacked and sunk. One Commander, I think, said he was sunk no less than seven times. The torpedo stations on shore were the objects of attack, and very brilliant attacks, too, which showed the powers of endurance of the seamen, powers which I was very proud of at the time. I think, taking it altogether, in all the cases I have seen, I would rather be without the light. I can remember a little incident in which I took part. It shows how very curiously the electric light may act in some cases. The squadron inside the rectangle of light was in total darkness, and my boat, in which I was inspecting the preparations, happened to get within the beam of one of the ships showing the light. Just as this happened I saw a boat inshore of me. I thought she was one of the attacking boats steaming up inshore. Of coure I set to work to cut her off, as I was commanding the defending squadron. I steamed as hard as ever I could. I got my muskets ready, and so on. Still she went past me, going inshore as I thought, and it was not until I recognized my own shadow shaking its fist at the engineer for not clapping on more steam that I found I was chasing the shadow of my own boat thrown on the cliff. In a very few seconds I should have been hard and fast ashore. I should like to hear other opinions with regard to the electric light, because I think it is a very important matter in connection with torpedo warfare.

Lieutenant F. C. D. STURDEE, R.N.: I have been referred to by the lecturer as having received a verbal invitation to deliver a lecture in this Institution upon torpedo-boats. I very much regret not being in a position to do so. The first point that struck me in reading Mr. Laird Clowes' lecture was his want of faith in the torpedo, on which the whole value of the torpedo-boat depends, as all through he infers that the weapon is unreliable, and that there is a strong probability of mistakes being made in using it. The next point is that he appeared to reduce to a minimum the amount of dash which is required from torpedo-boat Officers. Now, as far as I can see, in order to make a successful attack these Officers must be encouraged to risk everything when they have once made up their minds to deliver the attack. When attacking they must not think about their own life or about what may happen to the boat, but simply try to do the best they can without thinking how to retreat afterwards. I feel sure torpedo-boat Officers will attack in this spirit. The paper seems to convey the idea that you can arrange all your details beforehand, just as if you were making out "a railway time bill." Now, from my experience, I am persuaded that that cannot be done. But I would like first to confine my remarks to the weapon; we know that the Whitehead torpedo has only been in existence for the last twenty-five years. When it was invented in 1867 it was a comparatively insignificant weapon, having a speed of 6 knots for a short distance. In 1882 it possessed a speed of 20 knots for a 600 yards range, and now in 1892 it has a speed of 32 knots for 600 yards or 31 knots for 800 yards. The weapon may now be considered thoroughly reliable; every weak part has been thoroughly considered, and every possible improvement introduced, so as to render the weapon as perfect as possible. I have not the slightest doubt that very shortly the weapon will be still further improved, and a speed of 40 knots obtained, which, no doubt, Mr. Brotherhood, who, I observe, is here to-day, will be able to assist in obtaining, and that it will become a still more perfect and destructive weapon. Mr. Laird Clowes seems to think that it has already very nearly reached the final point of perfection and that very little is left to be desired. Besides its

increase of speed and reliability, the modern torpedo, if it comes to the surface during its run, is very seldom deflected out of its path; this was not the case with the older patterns, which, if they once came up, were liable to curve either way. This is a very important point with regard to what I am given to understand is one of the uses of the torpedo-gunboat class, viz., to catch and sink torpedo-boats; but to enable them to do this they must put themselves in a position from which the boat could easily sink them with one of their torpedoes, as they form a considerable torpedo target on account of their deep draught and length, so that a torpedo adjusted to run near the surface stands a very good chance of being effective. With the improvements introduced, there has been a considerable reduction in the number of failures. Of course there must be a certain percentage of failures with the most perfect torpedo. I am sure, if, when using any engine, you were to start it at full speed and leave no one to attend it, there would be a certain number of accidents. We must, therefore, recognize the probability of some failures; but the result is, on the whole, very good, when you consider in a Navy like ours there are about 13,000 torpedoes fired every year, and out of this large number very few are lost. Of course the fact of our having to recover torpedoes in peace is a great nuisance, as if a torpedo goes to the bottom it is a great inconvenience, perhaps, to the movements of a fleet, and this is one of the causes which probably prevent torpedoes rising in the estimation of Officers. If, after gun practice (supposing such a thing was possible), the shots had to be recovered, I hardly think the gun would be held in such high estimation, and that, probably, partly accounts for the feeling that sometimes exists against torpedoes. There is another point about the increase in the size of the target, and which is a very important one. Thus, if you look at the "Royal Sovereign" in Portsmouth Harbour you will see what an enormous target she offers to a torpedo. There is a ship drawing nearly 30 feet, and 360 feet long. Then there is another important question as to the value of nets. Captain Eardley-Wilmot said it was a repetition of the question of guns *versus* armour. But nets at the present, without considering net cutters, I suppose, are comparatively inefficient, because the torpedo can easily run under them. The fact that there is a want of realizing the rapid improvements which have been made in the torpedo by a large number of Officers, tends to keep down the number of torpedo-boats, and, according to "Nauticus's" letters in the "Indépendance Belge," we have only 13·9 per cent. of the total number of torpedo-boats possessed by the maritime Powers, whereas we should have 40 per cent. There is no doubt that the question as to the use of torpedoes in a fleet action has not yet been fully considered. I imagine that they will come very much to the front, and cannot help feeling very strongly upon the point because of the tremendous danger in these days of treating a weapon with contempt, or not giving it its proper value. Mr. Laird Clowes has mentioned my name with reference to the Plymouth attack in 1890. He complains that in this case, neither the organization nor the training was what it should have been. Now, as far as I have heard, the Plymouth attack was supposed to have been successful. There were nine torpedoes fired and six of them hit. I think these results may be considered fairly satisfactory, and taking the results of the different manœuvres, I find the percentage of hits is two out of every three torpedoes fired. To get these results shows the training was not bad, and as to the organization, every Officer knew the general idea of the attack, and every preparation was made before leaving Guernsey; there was no difficulty about keeping the boats together, as it was a clear night. There were six boats, and I think a division of six boats was not too much for the work that it had to accomplish. With six boats we could sink six ships. If there had been three boats, only three ships could have been sunk. The boats kept in close order up to the breakwater, and they were all well in hand, having been practised at station keeping beforehand. It was only a case of following the leader. There is another statement about the "flurry" in firing. Now, to take this particular case of an attack, as we approached the breakwater, we were not certain that we could get in; there might have been a boom across the entrance, or guard-boats; you never can tell what is going to happen. Everything being ready to discharge the torpedoes immediately the boats were discovered, they went at full speed and tried to fire their torpedoes as soon as possible. There is of

course haste, but not necessarily "flurry." About the large number of failures to run during the British Manœuvres of 1891, I do not think that is quite correct; there were three failures to hit out of nine, but some others were disputed. Unfortunately the ships had nets out. It would be a good thing in manœuvres if the nets were kept triced up, because it always leads to discussion afterwards as to whether the torpedo actually hit, and there can be no doubt if the head is damaged. The lecturer rather leads one to think that he has little familiarity with torpedoes, when he speaks of them having been fired "before they had been tested for floatability, and even before they have been charged with air." Testing for floatability is not at all necessary for action. The torpedoes were charged with air, but they had a leaky valve, a defect which has been obviated in more recent torpedoes. Then there is a point he mentions about the unreliability of torpedoes and their being a danger to friends as well as foes. I quite grant that any neutral ships anchored amongst a fleet in the Sound, for instance, would have a bad time. I should be very sorry to be in a neutral ship in harbour when a general torpedo attack is being made, because they must run considerable risk of being hit by a torpedo; there would not be time to distinguish the neutral ships from others. This would probably be equally true in a bombardment. The point which he states of one torpedo-boat being hit by another is not quite correct. The fact is, that No. 59's torpedo which missed the "Northumberland" went on to the breakwater. The torpedo that actually hit No. 51 was a torpedo that had already sunk the "Inconstant" and would have blown her up, and thus would have been expended and could not have hit the boat; but, as it was a dummy attack, the torpedo, after striking, ran under the bottom of the "Inconstant" and struck the boat on her other side. As to the torpedoes floating about after being fired, I remember seeing this in the newspapers, as if they had not run, or had of necessity missed the ship. That was not so; they were the torpedoes that had done their work, and were waiting to be picked up. On the question of organization, which is a very important point, and which has been referred to by previous speakers, the lecturer rather inferred that anyone can command a torpedo-boat. Now, I think it is a very important thing that young men should be always selected to command them, and therefore I would venture to suggest that all the comparatively short torpedo course which acting Sub-Lieutenants have on board the "Vernon" should be devoted to the Whitehead torpedo and handling of torpedo-boats, so as to better qualify them for command of these boats as either junior Lieutenants or Sub-Lieutenants. There is a very important point about mobilization. So far as I read, everyone is agreed that the torpedo-boat is to strike suddenly at most unexpected points; therefore on the first night of a war with any neighbouring Power, it is of the most vital importance that the boats should be ready to attack the ships in the enemy's harbour. To ensure success, this points to the increased importance of qualified Officers and men being available to man the boats without any preliminary practice. Are we in this position? And is the defence of our harbours and roadsteads where our ships are likely to assemble such that they will be safe from an attack from the enemy's boats on the first night of the war? There is a reference made to the Chilian War and to the torpedo-gunboats being driven off by the "Aconcagua." I pointed out in the discussion on Admiral Long's lecture on quick-firing guns that that was not the case. Torpedo-boats have principally been considered as attacking boats. When dealing with them in the matter of defence, there is another very important point that has not been brought out in the discussion, and that is, as to the deterring effect they would offer to an invasion. I fancy that soldiers would not be very anxious to embark in transports if they knew that they were liable to be sunk by torpedoes. It would be next to impossible to effectually defend a fleet of transports from a torpedo attack. I am of opinion in certain cases the boats would be most valuable attached to fleets as an auxiliary power, but not in any way to hamper their action, the boats being convoyed by a cruiser in case the weather gets so bad that they have to go into harbour. In this way in fine weather, in confined waters like the Mediterranean or the English Channel, an Admiral might be able to derive assistance from them. I am sure to establish an efficient blockade they will be indispensable, except in certain exposed places, but a small harbour will have to be occupied for the boats to

go into in the day-time to rest the crews, &c. They were of the greatest assistance in the Greek blockade in 1886, where only the small types of boats were used, but the weather was fine. At Bantry Bay in 1888, the forcing of the blockade would not have been known, but for the boats, and one of them torpedoed the flagship; the question of hitting is, however, disputed. Any fleet forcing a blockade will bring their torpedo-boats out with them, and will thus have an advantage over the blockading fleet if they have none; besides, these boats would have been continually harassing the blockading fleet. The lecturer lays great stress on the advantages of divisional boats. Personally, I do not see any use in them. It is a great nuisance for the leading boat to draw more water than the other ones following, as it is of the greatest advantage for the boats to be able to go over shoals; and to do this, they must draw very little water. I see by the Naval Estimates we are going to build ten new boats, and I do trust that they will be slightly larger boats than No. 82 type, as more boiler power is wanted to maintain the speed of the present craft, and that brings me to another point, namely, that it is a great mistake to organize boats of unequal power in the same flotilla. If the boats have the same turning power and the same speed, there is nothing like the same danger of collision. Captain Eardley-Wilmot pointed out one of the differences between the last manœuvres and actual war was that in the former case you know exactly where the ships are. This was not quite the case, as the boats had to do all the scouting, because there were no more suitable vessels to do it for them, and therefore they were under considerable disadvantages, besides which Admiral Long could steam up and down our coast and bombard our harbours with impunity and we could do nothing, not even having the moral force of any ships to prevent this happening, so that the proper value of torpedo-boat stations was not sufficiently tested. With the growing importance of torpedoes it is necessary that all cruisers should carry a steamboat of such a size that torpedoes can be fired from it. This is of the highest importance, as these ships will principally compose our squadrons on distant stations, where there may be no 1st class torpedo-boats at hand.

Lieutenant BACON: I do not think there is very much left that I can say following Lieutenant Sturdee, but there are one or two points on which I may say a word. The first is as to the remarks on the errors made by Officers in charge in the attack in 1891 manœuvres. Nearly all errors made by Officers in charge of boats are due to want of practice. You have young Officers, and if you want them to be of much use, you do not want them to be too cautious. If you have young Officers, you must train them. The training that young Officers at present get before going into boats is very small indeed. They require some considerable previous training to give them a thorough knowledge of torpedoes so that they may *really* be thoroughly efficient when they go into the boats. Mr. Laird Clowes says among other charges which have been touched on by Lieutenant Sturdee that he has been informed that many Lieutenants in command of boats have been in boats without proper instruments for navigation. Now navigating instruments are not much required in a torpedo-boat. A pair of parallel rulers, a pencil, and a half-crown clock will take you through most things. You do not want any refinement, as your cruises are comparatively short. The sextant is not much good if you have not got a chronometer. If you have not a chronometer, you cannot find the longitude, and therefore sights are but little good in the Channel where the courses are most often east and west; but if you know the course you are running and the speed, you have your charts, and you can do all the coast navigation required. When also you come to think that nearly all your navigation will have to be done at night, without showing a light, without being able to look at a chart, and without, perhaps, being able to look at your compass except for a second or so, then, I think, you will all own that Officers will have to be sent into torpedo-boats to be thoroughly trained, and not, as suggested by Mr. Laird Clowes, that the boats when commissioned should be simply left in charge of warrant officers. You must thoroughly train your Officers in the use of both the boats and torpedoes if you want them to be thoroughly efficient and have confidence in themselves and the weapons they use. A half-trained Officer is always thinking at the critical moment, when he wants his full attention and nerve, What have I forgotten? You can never thoroughly appreciate how much you have to learn to command a

torpedo-boat until you are actually standing on the deck of such a boat going into a harbour where ships are at anchor, and you practise yourself determining how you would attack them. That is a question that is never forced upon you thoroughly until you are in charge of a boat. It is the same thing when you meet a ship at sea. You come across a steamer, make a dummy attack, and perhaps suddenly think, What would I do if she suddenly put her helm hard-a-port? You must be on the boat, and you must have had the experience, in order to thoroughly impress the whole thing in your mind. If you want Officers to have confidence in their boats, they must have practice. Another point in the lecture I cannot agree with is that all through it, to my mind, there seems an underlying vein of caution. All the attacks are arranged with a view of saving the torpedo-boat: you are not to go on if you get fired at; retreat in one case is advised when fired at. Now the very last thing that I think we should teach Officers in command of torpedo-boats is to be cautious. In ordinary peace-time going into a harbour, picking up your buoy, going in and out of dock, and that sort of thing, they cannot be too cautious: if they risk their boats unnecessarily, it is a bad thing; but when once they are doing business outside, proceeding to or making an attack, then do not risk the chance of success by being over-cautious. If you are going to set the safety of the boats against every possible risk, there will sure to be a failure. The boat that remains in the beam when seen and thereby attracting the gun fire, or the boat that goes for the boom and either jumps over it and carries on the attack or sticks there and uses all her remaining resources to blow it up, those are the boats that make an attack successful, and not the boats that crawl slowly to avoid being seen. In this the Admiralty have always been most good. When boats in manœuvres have gone ashore through not being over-cautious, then they have taken no serious notice about it, and the consequence is now you always find Officers only too glad to go to torpedo-boats, since they feel they have a free hand, can use their sense, and have not always to exercise too great caution. One reason I disagree with divisional boats is that it destroys the individual sense of responsibility in the Captains of boats; it is much the same as in the case of a squadron where with a flagship the other ships are not so careful about navigation. If you have your torpedo-boats following the leading boat up the coast, they are not so careful with their individual navigation, and this will be intensified the more you provide the divisional boat with extra facilities for navigation. One way to prove this is, if you are leading the flotilla, to alter your course at night point by point, and then in the morning ask the other boats where they are. If they do not do their own navigation, they will not know how to do it when required. Then there is another thing about divisional boats. Boats can succour one another; they do not require the divisional boat. You get two or three torpedo-boats together, and if the Officers in charge are worth anything, they can help one another. Torpedo-boats can tow one another 10 or 12 knots without much difficulty, and they can succour one another and without the help of a divisional boat. If torpedo-boats are used as raiders, your divisional boats will be in the way; but if you are going to use them as scouts, they may be of use. If torpedo-boats are used in the anomalous position of doing their own scouting and making their own attacks as in the 1891 manœuvres, then a bigger class of boat would be of use to do the scouting, and not have to send your ordinary torpedo-boat out for miles on that work. Then as to retreat, I think the principle of retreat with torpedo-boats ought to be treated with very great caution. You must look at it in this way. When once there, it is far more dangerous to go back than to go on. If you are seen, there is far more chance for you in pushing on than in turning round and having a stern chase all the way back. There is one point that I do not think has been sufficiently considered, and that is, that if you are attacking ships in harbour and one of them is blown up, a panic will be created on the other ships at anchor. Everyone knows that a 20-lb. charge of guncotton will give a ship's bottom a good blow, and if you explode 100 lbs. of guncotton close to another ship, I believe there will be such a panic created that you will have all the magazines of the remaining ships cleared. That is another reason why you should push on and strike a successful blow. It is really the safest policy for youself to adopt. I also do not see the use of feints. It always seems to me that if you are

close enough to make a feint, you are close enough to make an attack. In these torpedo-boat attacks, you are not merely dealing with old-fashioned edged tools, you are dealing with a far more dangerous weapon, "guncotton," so you must expect to run more risks, and I do not think the boats ought to come back as long as a ship remains unsunk and they have a torpedo left. When once the attack is to be commenced, I think it should be clearly understood that each boat must act independently. One boat can get a shot off at one ship while another one cannot. You must attack independently, and then afterwards return either to a rendezvous or by yourselves. About getting out; if they can get in, I am perfectly certain they will get out much more easily, because all the ships will be employed either in looking after themselves or in looking after sinking ships. With regard to search lights, I quite agree with the lecturer. It is a fact that we have not got the slightest thing to go on in the way of experiment with search lights against torpedo-boats and guns. We have the results of a few experiments with search lights and torpedo-boats some few years ago by different observers on different stations, but there has never been anything really authentic of late years which has added materially to our knowledge on the subject of firing guns with search lights at torpedo-boats. It is one thing to find torpedo-boats, but it is a very different thing to keep your light on your boat and hit her with gun fire; therefore, whether your search light would be of any use or not in its present position is a point that I do not think has ever yet been satisfactorily decided.

Commander JOHN DENISON: My experience with torpedo-boats has not been so great as that of the last two speakers, but I should like to say a few words. I coincide with nearly everything they have said. The moral effect of torpedo-boats is very great. A fleet blockading an enemy's harbour must expect continual attacks from the torpedo-boats in the harbour, and nothing will tend so much to demoralize the men and Officers as these attacks. The lecturer has told us he thinks it is better to make separate attacks on a fleet by small divisions. I think, however, that if a fleet can be thrown into confusion by a general attack, the boats would have a better chance of getting in their torpedoes. As for torpedo-boats attacking ships at anchor in harbour, it will be a rather difficult thing for them to do, because a fleet anchored would naturally have guard-boats outside to check the torpedo-boats coming in. If they got in they would be expected, and the fleet would probably be able to deal with them. Then, again, torpedo-boats which have attacked a fleet at anchor, and are returning to their bases, must naturally expect to be chased. Their engines might break down; their coals might run short; their water might run short; and the chances are they would be overtaken and sunk, or destroyed. I quite agree with the torpedo Officers in thinking that we are inclined, perhaps, to under-rate the value of torpedo-boats. They are always most useful, and must be considered as great adjuncts to a fleet.

Mr. THORNYCROFT: I agree with the lecturer, and I feel that the meeting has taken the same view, to a great extent, that torpedo-boats are better adapted for sudden and unexpected attack, than to accompany a fleet, which was the function originally assigned to them. At the same time, I think too much stress has been laid on the idea that torpedo-boats are not able to keep the sea, especially as one speaker has told us that two French torpedo-boats were able to accompany the French fleet for six months. I think if torpedo-boats could, somehow or other, be organized in such a way as to enable them during bad weather, which is the exception, and not the rule, to find shelter, I think, there is no doubt, torpedo-boats might be of very great service. There is one thing I must regret, that is, that my firm has built its best torpedo-boats for abroad, and I think the evidence before us seems to show that increasing the power and size of boats enables them to act at greater distances and with greater promptitude. The experience we have had with boats of about 150 feet is that, really, in moderate weather, their speed is very little reduced by the waves. We have lately had information from Rio that a boat we sent out there made the voyage of 6,000 miles, and, on arriving there, was in such good condition that, with masts standing, awning and everything up, the boat was able to maintain a speed of 22 knots without any special preparation. In its best condition it made 25 knots, but after steaming 6,000 miles to maintain a speed of 22 knots says a great deal for the power of these boats. With regard to the

torpedo, I am not so well informed as to how perfect it is. We are told to-day that it has been greatly perfected, and now has a speed of 32 knots, and that it is perfect in every way; but it has been suggested that in actual fight, when ships get confused, it would be equally dangerous both to friend or foe. I think that is curable. There is no reason that they should remain so. I do not know if the torpedoes are so made, as it were, to lose their sting after so many seconds, because it is quite conceivable that it is not at all mechanically difficult to make them so far cut off their detonating apparatus as to render them quite harmless after they have made a run of some prescribed time.

Admiral COLOMB: We have had such a very excellent discussion, and so very close—one of the best I have heard here—that I do not propose to say very much at this late hour. But I feel, to a certain extent, a target on this question of torpedo-boats, and wish to say one or two words on the more general part of the question. The lecturer was cautious, as he has been described, in not giving too much force to the torpedo-boat; but he did give it immense force. Subsequent speakers, especially my friends from the "Vernon," have claimed that the torpedo-boat, by the lecturer, has been somewhat disparaged, that its force is very much greater than he seems to allow. Other speakers have followed in the same way, and the point which strikes me is that the whole of the discussion, or nearly the whole, to-day has been as if every speaker was on the side of the inferior naval force: that is to say, that the whole action described is the action of those who evade open, fair, downright warfare. There was a certain bard who tried to make a song that might suit the "Vernon," and the refrain of it ran something in this way, if I can only recollect it:—

"Yes we think this the straightest tip,
Fal lal lal la, fal lal lal la!
Presaging times not far remote,
Fal lal lal la, la!
'Twill cause our foes their flags to dip
When everything that moves afloat,
In either a big torpedo-ship
Or else a little torpedo-boat."

The point, which is quite a serious one, is this: That if the torpedo-boat is to be taken as we are now taking it, it means a great deal more than any speaker has as yet recognized. If things are to be as described, there is nothing to be said for the battle-ship, or for the heavy cruiser; scarcely anything for the smaller vessel, which is called the torpedo-catcher. We are getting a force—or we say we are getting a force—which is certainly to alter all that we know of the practice of warfare; and the point for us seems to me to be, how are we going to meet this? It is quite certain, I suppose, if torpedo-boat attack is what it is represented to be, we, in this country, are far more open to it than any other nation under the sun in war. Our ports are more numerous, our shipping is more numerous, our war-ships are a great deal more numerous; therefore they offer greater opportunity for attack. But we have not heard from any speaker that if the torpedo-boat is what is represented, what it behoves us to do is to guard against the torpedo-boat—that that should be almost our whole aim. If it can be said that the torpedo-boat herself is the answer to the torpedo-boat, let us go on with it. But we have not heard that said. And I do not see that we are paying any sort of that attention which we ought to pay not to resisting the attack when it comes, but to preventing the torpedo-boat attack, to prevent the enemy's torpedo-boats from issuing from their harbours, which, it seems to me, is the thing we have to look out for. I say this, because I think that it is the point most strongly brought before us by its remarkable omission in this lecture. I do not like to sit down without congratulating Mr. Laird Clowes most heartily for the lecture he has given us, and personally, on my own behalf, because if he had not done it I should have had to have done it, and I could not have done it with anything of the same skill and clearness, and lucidity, which he has brought to bear upon this subject.

Admiral Sir W. HOUSTON STEWART: There is no time to say much on this subject, which has so far advanced since my time of active service. I was the first

person who brought the torpedo-boat officially to the notice of the Admiralty, about twenty years ago. I was the first person who officially urged upon the Admiralty the importance of building a torpedo-boat for experiment. My suggestions, or my recommendations, on the subject were not attended to for a very considerable time, and we were much behind foreign navies for many years in torpedo-boats. The naval Officers at the Admiralty at that time did not consider that they were necessary for us. Having always held a different opinion, I therefore rejoice that the torpedo-boat, whatever may be the difference of opinion as to its application, has advanced so much more in consideration as an element of our Navy. But it is not as their advocate that I rise; it is as an old member of this Institution, to express my exceeding gratification that young Officers who have had practical experience themselves, and are therefore the best qualified to give us opinions on this subject, have come forward in the Institution and spoken, as they have done to-day, in such clear and admirable speeches. At the same time, I should like to express my great delight in having listened to such an admirable lecture from Mr. Laird Clowes.

Captain MAY, R.N.: I have very few words to say. Admiral Colomb has forestalled me. But looking at the fact that we are the people who will be attacked by the torpedoes, it more behoves us to defend ourselves than to scheme out plans of attack. Admiral Long has shown us that within 100 miles of the enemy's coast—140 miles, he said—we are within range of his torpedo-boats. There was one point which has not been traversed, but I think it ought either to be traversed or concurred in, and that is, that we are not to count on being attacked by torpedo-boats if we are fortunate enough to get the enemy's fleet to sea and have a fleet action. Admiral Colomb will bear me out if I say that 99 great sea-fights out of 100 have been within 100 miles of land. Are we to suppose that the enemy, who from the warfare that has taken place previously has gained experience and confidence in his torpedo-boats, will not take the boats out when he has confidence enough to bring his big ships out? I am perfectly sure if we are fortunate enough to get the enemy out, as Nelson got him out at Trafalgar, that he will bring out his torpedo-boats with him. How are we to meet them? Perhaps I have seen more experiments, or as many experiments, with the gun as most of the Officers in this theatre, and I am sorry to say, notwithstanding all we see on paper about the quick-firing guns and the number of projectiles that can be fired, the essential thing, the number of hits, has not, as far as I have seen, gone up so very much that we can be sure of stopping torpedo-boats by the gun. It appears to me that if these torpedo-boats are to be stopped and checkmated it must be by other boats. The big ships must trust to their small satellites, and the small satellites must hunt down the enemy's boats, and therefore, if we can get another lecturer as good as Mr. Laird Clowes to tell us how we can organize, how we can practise—because without peace practice there is no war efficiency—with these small satellites, and so hunt down and checkmate torpedo-boats, then I think we shall have advanced a step further in the tactics of the future.

Mr. LAIRD CLOWES (in reply): I feel, as I said when I began my lecture, that the subject before us is really so wide that it is perfectly impossible to attempt to deal in the course of a single lecture with all the points which naturally crop up. I made my lecture as comprehensive as I possibly could. After I had written it, I struck out a great deal, because I found I could not get it in in the time, and I think it is unfair for critics of mine to come and say, "Well, you have not treated the electric light," and "You have not done so and so." I could not do any more in the time; it was actually impossible. With regard to the use of the electric light, that is a subject of a special lecture. You cannot treat it at the tail of a lecture like this. The only point upon which I want to speak is the fact that I have been charged by several speakers with a tendency to repress dash. Now it is not for me to encourage dash or otherwise, but it is for me to take the position of an outsider, and to speak as an outsider. It is not for me to pass any opinion upon whether an Officer ought to betray more dash or less dash; that is a matter for the Officer, and that is the point where one Officer differs from another Officer. But there are certain rules and general principles which must be recognized quite apart from the individual dash of Officers, and I certainly never had the intention of saying a single word which should tend to repress dash, because, as every one

knows, the whole of torpedo warfare must depend upon dash. The suggestion by Mr. Thornycroft that the sting of a torpedo might be taken away after a certain length of time seems to be exceedingly valuable. I think it would, if carried out, do away with some of the objections that may be urged against the employment of torpedoes in fleet action. If, supposing you missed your mark, the torpedo at once became harmless, you could fire your torpedo and feel perfectly happy that if it hit your own friend on the other side it would not do any damage. But at the present time if a torpedo is fired from a battle-ship, or a cruiser, or from a torpedo-boat, in a fleet action, and you do happen to miss your mark, you do not know where your torpedo is going, or what it is going to hit, and you would be likely to do as much harm to friends as to foes. With regard to Admiral Colomb, he starts an entirely separate topic, how to meet torpedo attack. That is, I think, a subject for several lectures, but I do not see how it can be dealt with to-day. First of all it would not bear upon the point which is before us, and, although it is interesting, I do not see why I should be reproached for not having touched upon it. For Sir Houston Stewart's kind observations I am very much obliged. With regard to the point raised by Captain May, I agree with him that fleet actions in the future, as in the past, are likely to be fought within a short distance of the coast. But the whole question of torpedo-boats with fleets does not depend upon the sea-keeping qualities of torpedo-boats so much as upon the fact that they cannot keep up in anything like bad weather with a fleet, when the fleet is doing 11 or 12 knots, and if you send a fleet to sea and hamper it by taking on a flotilla of torpedo-boats, which cannot do more than 11 knots, what is the use of giving your battle-ships 16 knots. I am sure I am very much obliged for the kind way in which my lecture has been received and spoken of by Officers who I fully expected would "jump" upon me.

The CHAIRMAN (Sir Geoffrey Hornby): Gentlemen, after the time that we have spent already in this theatre, I feel that the fewer words I have to say, the better. As an old Officer, who has nothing further to do, I believe, with torpedo-boats and torpedo-ships, except that I have a son in the Navy, I have this remark to make, that I think that the consensus of opinion appears amongst torpedo Officers to be that they are not very certain of their operations. I hope myself, therefore, that the ship in which my son navigates will not be blown up by one of these torpedo-boats! At the same time, I believe I had the honour to command the first squadron that went to sea with torpedo-boats, and I certainly looked upon them with great interest, and felt convinced that they had a great future before them. But I look upon their future as regards the squadron in two ways: they are the attackers certainly, but they are also the defenders. It is to my mind exactly the case of David and Goliath between the ironclad and the torpedo-boat. If the ironclad is not very quick indeed, the torpedo-boat will inevitably slip him, so that he falls a prey to a much smaller vessel. But there is one thing with regard to the torpedo-boat, which has been touched upon and which I endorse entirely, namely, that we do not give her her position in war. I do not consider that we have the means of judging what the position of the torpedo-boat in war will be; war itself must show. But I speak of what the torpedo-boat can do in time of peace. I look upon her as the most valuable vessel we have got to enable young Officers to learn what is of principal utility in their profession, that is, how to handle a vessel, how to handle it smartly, and how to handle vessels at great speed. I should like to see torpedo-boats of all sorts attached to our different squadrons, and made parts of those squadrons, as they must be when we get to war. When they are attached and working with squadrons, that is to say, a boat attached to each ship, there arises immediately a valuable rivalry between ship and ship and boat and boat, which does everything for improvement; whereas so long as they are simply in a school attached to a school you have the deadening effect of doing the same thing over and over again without there being progress. Another thing I have watched very carefully is the class of men we make by these torpedo-boats, and I am glad to say that they are a class which I hold in the highest respect. I am quite sure anything that is to be done with these boats will be done by these young men, and if I was going to sea again I should not trouble my head to tell them how they were to go into action. I look upon these young men as men who go straight

to the point when they can see it, and the probability is they will see it from the position they are in in their boats long before I can from my ship, and, therefore, I should leave that entirely to them. The only thing I should safeguard is that I should insist, before the action commenced, on giving them every protection I possibly could from those ironclads whose protection is the *raison d'être* of the attack on an opponent. I look upon it the ironclad and the torpedo-boat ought to look upon one another as comrades, the one protecting the other from fire, the smaller boat protecting the ironclad from that deadly weapon, which there is no doubt we ought to hold in great respect, and which I hope we shall do. I am sure we are very much indebted to the lecturer for a most interesting lecture, and also to those gentlemen who have said so much in elucidation of the subject.

Lieutenant-Colonel BAYLIS: We have already given a vote of thanks to our lecturer for his very able and instructive lecture, but I think we must all concur that we have another duty to perform, viz., to give a vote of thanks to Admiral of the Fleet Sir Geoffrey Hornby, for coming to preside on this occasion. His remarks to young men have been most admirable, and I am sure I hope they will go far and wide to encourage all young men in regard to what he said.

Admiral Sir HOUSTON STEWART: The honour of seconding this vote of thanks has been given to me, and I think it a very a great honour. We owe our Chairman a vote of thanks not only for presiding here to-day, but for the most admirable instruction that he has given us. In that instruction he has followed out Nelson's ideas: he said to the young, tried and trusted man, "There is your enemy—go at him!"

The CHAIRMAN: I am much obliged to you for your kind remarks.

FOREIGN SECTION.

THIS portion of the Number, hitherto the Occasional Notes, has now become the Foreign Section, and is reserved for articles, either original or compiled, on professional subjects connected with Foreign Naval and Military matters; also for notices of Professional Books, either Foreign or English.

The Council of the Institution wish that this section shall be developed still further, and I have undertaken to continue my Editorship during the current year, with a view of aiding them in carrying out this work. It seems to me possible to make this section, and consequently the Journal, the means of keeping our Members acquainted with all naval and military progress abroad *pari passu* with that progress; and I shall be glad to receive from members of both Services, including in the latter those of the Auxiliary Forces, suggestions, information, or offers of assistance.

It is desirable, further, that I should state that, as regards editing the Naval matter in the Section, I shall have the aid of Naval Officers, thoroughly competent to give good advice and to pronounce sound opinions.

It must, however, be borne in mind that, as the change from a quarterly to a monthly issue has been made in order to ensure the more prompt publication of the Lectures after their delivery than has hitherto been the case, the Foreign Section will, as a rule, be restricted in extent during the Lecture season in the first half of the year, and will be prominent in the second half.

It is requested that communications and books for review (the latter under cover to the Librarian) may be addressed to me at the Royal United Service Institution, Whitehall Yard, London, S.W.

LONSDALE HALE,
Colonel R.E. ret.

PROFESSOR FRÖLICH'S NEW METHOD FOR DETERMINING THE VELOCITY OF A PROJECTILE IN THE GUN.

Translated from the "Rivista Marittima" by THOMAS J. HADDY, Chief Engineer, R.N.

A NEW method for determining the velocity of the projectile during its passage through the gun, is the result of a series of experiments carried out by Professor Frölich in order to demonstrate and analyze the movements of telephonic membranes.

To explain the method, I ought, naturally, to go through this series of intelligent researches, but at the present I will only observe that it aims at doing away with the necessity of piercing the gun at various points, as is necessary in using the chronographs of Boulangé, Siemens and Halski, Bashfort and Sebert, an advantage which, according to all the evidence, would be of no little utility.

Professor Frölich set out on his researches with the following conception, viz., that:—

In spite of the great diffusion of the telephone and the numerous investigations carried out on its effects, until about three years ago no investigation had succeeded in demonstrating experimentally the movements of the telephonic membrane, and, as a consequence, to indicate by experiment the properties of these movements.

In general, the experimental demonstration of the movements of the telephonic membrane is simple enough, if we pass through the telephone alternating currents sufficiently intense, by means of a tuning-fork actuated electrically; but the same experiment becomes much more difficult when the telephone is acted upon simply by currents produced by the act of singing or speaking into another telephonic or microphonic apparatus. In fact, if, in order to have a trace of the vibration of the membrane, we cover it with lycopodium powder, it is not possible to recognize in this latter case any sonorous figure whatever.

We have, however, proof of the movements of the membrane if (on the idea of Professor Frölich) we fix firmly on the vibrating membrane, in an eccentric position (as nearly as possible in the middle of a radius), a small mirror so that a luminous ray can be reflected from it on to a diaphragm, as in Fig. 1.

By this means we observe a small movement and can measure it if, with the above arrangement, we add a microscopic lens and a graduated scale. Under these conditions at the laboratory of Siemens and Holske, at Berlin, they have been enabled to state that the maximum movement was 0·035 mm.

After this result, it was wished to render the demonstration more evident, by the transmission of the vibrations of the telephonic

Professor Frölich's
new method of determining the velocity of a projectile in the gun.

Fig. 1.

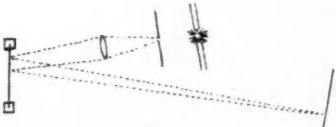


Fig. 2.

Fig. 3.

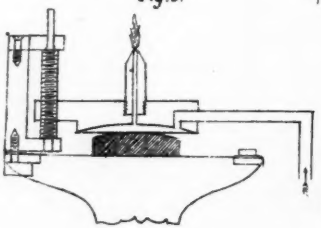


Fig. 4

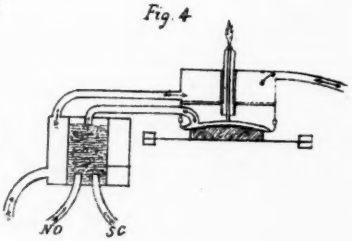


Fig. 5.

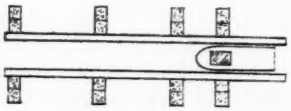
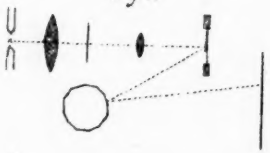


Fig. 6.

Fig. 7.



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membrane to a metallic cord fixed at one extremity to the membrane, and held in tension by means of a spiral spring attached to the other, as shown in Fig. 2; the metallic cord in the said experiment had a length of 40 cm. and a diameter of 0·6 mm.

With this arrangement, on passing the alternating currents of an electric tuning-fork, vibrations of the cord of an amplitude of 5 mm. were observed. The amplitude of the vibrations were afterwards largely increased by the addition of a small mirror fixed on the cord between the loop and node of the vibration, and by this means (not by the somewhat intense action of the tuning-fork, but simply by that of the voice singing into an ordinary microphone) movements from the diaphragm have been obtained even up to 50 cm.

However, although by these experiments the movement of the telephonic membrane (which, previously admitted by all, up till now had not been demonstrated experimentally) must be classed amongst the number of verifications obtained, still it is to be observed that the method above described does not lend itself to the study of the vibrations of the membrane, since the vibrations of the cord are essentially different from them. With a view of brevity, I leave out of consideration at this point any of the experimental demonstrations on the changes of timbre produced by the different methods of vibrating the telephonic membrane which Professor Frölich has given by means of the acoustic figures of Lissajoux, and will proceed in explanation of the experimental methods for obtaining a direct optical representation of the movements of this membrane.

As we know, one of the finest experiments in acoustics is that of the sensitive flame or dancing flame of König, by means of which we can directly represent the vibrations of the membrane. If a capsule, through which an inflammable gas is passed, be mounted on a vibrating membrane and the gas be lighted, the flame will assume a vibratory movement on the slightest agitation of the membrane, and on observing the image of the flame on a system of revolving mirrors, we notice a series of undulations more or less profound in correspondence with the vibration of the membrane. This experiment in acoustics, although well known, had not been applied by anyone to the study of the movements of the telephonic membrane before so applied by Professor Frölich, because these movements are about twenty times smaller than those produced in the usual acoustic experiments. Wishing to show that the experiment above indicated was possible, Frölich introduced the following modifications:—

In the middle of the telephonic membrane he fixed a small piece of cork, curved on its upper surface, on which rested a capsule having a chamber and very fine tube, and provided with an exceedingly thin membrane forming the bottom of the chamber, the whole adjustable to the greatest nicety by a micrometric screw, as shown in Fig. 3.

With this arrangement Frölich was able to represent the telephonic vibrations as clearly as in the acoustic experiments of König, the enlargement obtained being considerable. Again, with a view of brevity, I omit mention of the known results in the variation in timbre, the different vowels and consonants, and the essential

difference existing in the oscillations of the telephonic membrane, and those of the membrane against which we speak directly, results which, in their conclusions, are demonstrated to be in accord with those obtained on an artificial telephonic line, corresponding with that between Paris and Brussels or Berlin and Hanover. Evidently, if in any way we can succeed in fixing the image produced by the telephone and sensitive flame, this apparatus will become a measuring instrument that may be applied to a great number of important problems. For the rest, the above images express, although somewhat imperfectly, a measure of the relative movements of the telephonic membrane. In order to fix these images, we can have recourse to two methods, drawing by hand, and photography. Drawing, for the end we are speaking of, is shown to be too imperfect, and in any case for it to be at all satisfactory it is necessary to regulate the velocity of the revolving mirrors so as to obtain images with sufficient rapidity of reproduction as to appear fixed. It would be sufficient, however, to draw the characteristic parts only, especially the maxima and minima, and with a graduated scale the height of these points could then be measured. For greater accuracy we must have recourse to photography, but, again, this method presents difficulties, the duration of a point of the flame being so excessively short. The only means amongst the many experimented on which has given images sufficiently clear, is that proposed by Professor Sell, in which the flame consists of a combination of bisulphuret of carbon and protoxide of azote.

The arrangement adopted was that represented in Fig. 4.

With this the two gases combine in a chamber provided with a metallic cloth partition, traverse the closed capsule of the membrane, and ignite on exit. The whole of the circulating passage is maintained at a proper temperature to prevent the precipitation of the sulphurous carbon, by means of hot water. It being thus rendered possible to obtain sufficiently clear images of the points of the flame, numerous applications have become feasible; I will mention, but not describe, among others, the following:—determination of the curve of intensity during the variable period of a current; representation of the charging and discharging of an electric condenser; variation of the currents of the alternating current machine, thanks to which, can be put under direct proof all the changes that can be made in machines of this kind; application to chronography. This last application admits in its turn of many others. By means of a photographic plate divided into many parts, and each of these being attached to the face of a revolving polygonal system, we may repeat the celebrated experiment of Wheatstone on the velocity of the propagation of electricity, and this method is certainly superior to many others of the same nature of research, because the telephone would furnish the means to follow directly the movement of transmission along a line. In the same order of facts, the idea presented itself to Professor Frölich that the apparatus might be used advantageously for the determination of the velocity of a projectile in its passage through the gun. Instead of piercing the arm at various distances in

order to introduce insulated wires charged by means of the Leyden jar, and connected with electromagnetic apparatus and traversed by currents from the pile battery or accumulators, which are broken in the passage of the projectile, the desired result may be obtained in the following manner. First, it is sufficient to furnish the projectile (of lead, suppose) with a piece of soft iron, and to coil round the outside of the gun a system of spirals, composed of a primary wire, traversed by a current of a certain intensity, and by a secondary wire joined to a telephone (Fig. 5), to this should be then connected the proper accessories for the registration of the indications which have been previously chosen.

Evidently the projectile in its course will set up alternating currents (in the coils), and we know that in a closed circuit the electromotive force of induction is equal in value at every instant to $\frac{dQ}{dt}$ for the time that the flow of force traverses it, and the intensity of the induced current is $I = \frac{dQ}{Rdt}$ if R is the resistance of the circuit in which it circulates.

Now, if K is the coefficient of magnetization of the iron employed, the intensity of magnetization would be $I' = KH$. H representing the magnetic intensity of the field, and if B and μ respectively represent the flow of induction per unit of surface (or magnetic induction), and the coefficient of magnetic permeability of the iron :—

$$\mu = 1 + 4\pi K,$$
$$H = 4\pi n_1 i,$$

approximately; n being the number of coils per unit of length and i the intensity of the current in the primary circuit (Fig. 6).

Then, $$B = \mu H = \mu \times 4\pi n_1 i = 4\pi n_1 i(1 + 4\pi K),$$

and for the whole section S of the bar and for n coils of the secondary circuit

$$Q = nBS = 4\pi n_1 niS(1 + 4\pi K).$$

If, then, we consider S′ to be the section of the soft iron nucleus and S the section of the coil of the primary circuit (as the figure represents) the total flow that would traverse the n coils of a secondary system connected with the telephone would be—

$$Q = nH(S - S' + \mu S') = n \times 4\pi n_1 i(S + 4\pi KS'),$$

which is reduced to the above expression for $S = S'$.

Now, photographing the variations of the current by the method indicated, we have a means of determining (according to the velocity of rotation of the revolving system and the intervals between the maxima of the curve) the interval of time employed by the projectile in passing from one system of coils to another, that is, to traverse a known distance.

Though this remains in principle the new method to determine the velocity of a projectile in the gun, it is still necessary for us to continue the series of researches as carried out by Professor Frölich, because it will be seen from them that the modes of obtaining the registrations which serve to calculate the velocity of the projectile may be notably different. Incidentally we may observe, as is evident, that if we find a method by which the vibrations of a telephonic membrane can be directly observed and fixed, we have a method of representing the electrical undulations of the alternating current, since (analogously to what is indicated in the method described) the telephone can be employed for the observation of the strongest alternate currents circulating in the primary circuit, if, by means of a secondary circuit, we send into them only currents of small power.

Now the modified method of the sensitive flame of König, although it renders possible the studies we have been considering, is shown to be insufficient for the purposes of exact research, such as the determination of the velocity of projectiles, since the picture of the images produced is always very imperfect, and the different attempts to photograph these images have not resulted in any practical and simple method.

The means that may be employed to fix these undulations rest either upon a mechanical or optical basis.

In the phono-autograph the vibrating body is furnished with a fixed point which rests lightly upon the smoked surface of a cylinder; on the phonograph the vibrations are impressed by means of a point on the tinfoil surface of a revolving cylinder, and by causing another point to pass over the impressions caused by the first we can reproduce the same vibrations on another sheet of tinfoil, or increase them by a suitable mechanical arrangement for the transmission of the movement.

Amongst the optical methods, that of Lissajoux is especially remarkable, because it serves to produce fixed images by means of another vibrating body, and we can then deduce, by a process of developments, the vibratory curve of one body, if the figure of the vibrations of the other is known.

The other methods make use of revolving mirrors, usually mounted in the form of a cube, which is caused to revolve on a central axis parallel to the surfaces to which the mirrors are attached; the direction of vibration must be parallel to the axis of the rotating system. This method, applied under different forms in physics, has, unfortunately, the inconvenience that it does not give direct or fixed images.

In order to represent the images, Fedderson made use of concave mirrors, causing the reflected ray to fall on a plane surface of glass and on a photographic slide, on which he obtained images of a very clear outline. This arrangement has been adopted in representing the electric spark. Oettingen modified this method by returning to the use of plane mirrors, throwing the reflected ray on a photographic slide, or on a revolving polygonal system of which the facets consisted of photographic plates. Professor Girard applied this last

system, but in which he substituted a cylinder covered with sensitised paper for the polygonal system, and for the light he used an arc light or the sparks of a Rhumkorff coil projected uniformly, so that the periodical regularity of the sparks might also serve as a measure of the time.

Frölich, observing that all these methods had their advantages and defects, saw also that some of them furnished that which he sought to obtain.

The phono-autograph, although its construction and mode of registration is simple enough, nevertheless does not give exact results, partly by reason of the friction of the point against the hard surface, and partly by the variable elasticity of the scribing point. Now the friction cannot possibly be prevented, even in the most perfect apparatus, as many unsuccessful attempts of the Siemens and Halske firm have shown; again, it is controllable with difficulty, and gives irregularities sufficiently noticeable in the curves of vibration of bodies.

These curves of vibration also change by reason of the mechanical resistance of the tinfoil, and it is for this reason that the sounds produced by this instrument differ from the original notes by having a more acute timbre. Besides this, one can imagine that it would be very difficult to construct an instrument for enlarging the impressions made on the surface of the phono-autograph so as to reproduce them without any error whatever.

The optical methods are exempt from these mechanical defects, but unfortunately they have others.

The method of Lissajoux has the property of showing the difference of phase by means of a curve of simple form, and possesses, besides, the great advantage of giving fixed images. Notwithstanding this, it is necessary to know with great exactness the curve of vibration of another body, and in any case what we see is not the required curve of vibration of the body, but the combination of two curves. The first is not obtained but by a process of development which we cannot entertain when treating of a curve of complicated form.

The method of the revolving mirrors of the ordinary form does not give fixed images. With the systems of Fedderson and Oettingen we have the images photographed, but they do not lend themselves to the study of all the facts, because they are too small. Besides these arrangements, without introducing some improvements in them, are suited only to the observation of phenomena which are produced once only, but for continuous vibrations (as in the case of many sung notes) we should obtain results too confused to be able to obtain from them any serious conclusion. Professor Frölich observed, also, that the method of Professor Girard and that proposed by him in 1887 did not furnish to the eye, during the experiment, any curve; so that he considered it necessary to continue his researches by means of the rotating mirrors so as to obtain images that could be drawn or photographed immediately, and, in either case, that they should be plainly observable during the experiment. In the new method recently definitely fixed upon, Frölich used a ray of light from an arc lamp

placed inside a box, which ray he caused to traverse two lenses, the one before, the other after it passed through the aperture in the box, and that he then reflected by a mirror placed at the centre of a radius of the telephonic membrane, and by a polygonal system of rotating mirrors on to a transparent diaphragm or photographic plate. (Fig. 7.)

If, up to this point, we have any notable improvement in the primitive method, it consists in having provided the greatest possible accuracy in the adjustment of the plane mirrors, since without this, instead of obtaining a constant curve during the rotation and the passage of a continuous current, we should have a most confused series of curves. He has also provided for the production of curves stable enough to be observed and measured with ease and accuracy.

In order that the curves should appear fixed, each mirror must be so adjusted as to reflect the same ray to exactly the same place, and as a consequence the velocity of rotation of the system must be in a determined agreement with the velocity of production of the vibrations which we wish to represent. Now if V_s expresses the number of revolutions per second of the revolving mirrors, and m is the number of mirrors, that is the number of faces of the polygon, $\frac{1}{V_s}$ will represent the time employed to complete one revolution, and $\frac{1}{mV_s}$ will be the time between the arrival of two successive rays from the prism at the same plane. This last must be an exact multiple (n, suppose) of the duration T of a vibration of the vibrating body in order that the image should be a fixed one; therefore—

$$\frac{1}{mV_s} = nT, \qquad T = \frac{1}{nmV_s}.$$

If, for example, the vibrating body is a telephonic membrane, and its vibrations are produced by means of an alternating current machine, which is mechanically connected with the rotating system, V_m being the number of revolutions of the machine per second, and x the number of complete periods of the current per revolution, the duration of the complete period will be—

$$T' = \frac{1}{V_m x},$$

and the conditions satisfying the production of a fixed image will be that—

$$T = \frac{1}{V_m x} = \frac{1}{nmV_s},$$

or that

$$\frac{V_m}{V_s} = \frac{nm}{x} = p.$$

p will then be the relation that must exist between the velocity of the rotatory system and that of the machine; naturally, though n, m, and x may be whole numbers, p cannot be.

We might easily succeed in obtaining the above relation by a system of toothed wheels, arranging that the vibrations are produced by a body put in movement so that there should be a constant connection between the velocity of rotation of the machine, the revolving mirrors, and the vibrations of the telephonic membrane. The method described of fixed images in constant relation to the velocity of the generator and the revolving mirrors has the advantage that the length of the wave of the image is independent of the velocity of rotation. With an apparatus accurately constructed the number of revolutions (which changes simultaneously at the generator and at the revolving system) can be modified at will, without modifying the length of the wave of the image, and, as a consequence, the construction of the apparatus can be arranged so as to produce the length of wave required.

The angle that the reflected ray from the mirror describes in the time that the system completes one revolution is $\frac{4\pi}{nm}$ (with the supposed data), and the length of the wave is $\frac{4\pi R}{nm}$, if R is the distance of the transparent diaphragm from the axis of the revolving mirrors.

In execution of this plan we may follow two methods, as in the experiments of Lissajoux, one objective, the other subjective. The first has been indicated, and we can obtain by it images suceptible of being drawn or photographed, but we have need of the intense light of the arc lamp. In the subjective method we use a petroleum lamp instead of an arc lamp, and a microscope instead of the diaphragm; we then obtain curves of light but cannot register them; on the other hand the apparatus becomes easily portable.

A special study of the qualities of the membrane must be made, the desired end being to find one that has no influence of its own, or the least influence possible, on the reproduction of the undulations. Professor Frölich has also studied this most important part of the subject, both theoretically and experimentally, but does not appear to have yet arrived at any definite conclusion. Up till now, the telephonic membrane of iron has shown itself to be the best, and this is also in agreement with what constructors of telephones have recognized to be also the best for the transmission of speech. In addition to this, in order for the apparatus to act with sufficient accuracy it is necessary that its construction should be of the greatest exactness, and its installation perfectly frigid.

In favour of the representative method above described, without entering into a long enumeration, we can understand how the application of it may be extended in the field of acoustics and electric vibrations in whatever manner they may be produced.

THE NAVAL SCHOOLS OF THE CHIEF CONTINENTAL POWERS. PART V.

(*Concluded from No.* 171.)

Compiled by Major W. TENISON, the Manchester Regiment, from papers in the "Rivista Marittima," by 1st Class Commissary DANTE PARENTI.

Italy (continued).

In awarding marks in the written examinations, particular notice is taken of the candidate's handwriting.

In oral examination, two questions chosen at haphazard are set to each candidate in each subject. The Board has, however, the power to set a greater number of questions, if found necessary. Every candidate who fails to obtain 10 marks in arithmetic and Italian is debarred from continuing the examination. Those who obtain not less than 10 marks in these two subjects are permitted to continue the examination, and are declared successful if they obtain an average of 10 marks in all subjects. The votes of the examiners for each individual candidate are taken in the following manner: each examiner is furnished with a certain number of black and white balls, with which he records his vote as to the fitness of the candidate. This takes place secretly. Afterwards, by means of marks from 0 to 20, the candidate's position in the final classification is fixed. All who obtain 9 and under are returned unsuccessful, whilst those who obtain 10 and over are passed. The result is published. The averages of marks for classification in each subject are obtained for every candidate by adding the marks given by each individual examiner, and dividing the total by the number of examiners.

The final average is obtained by multiplying the marks obtained in each obligatory subject as above by the corresponding coefficient, adding together the products and dividing the total obtained by the sum of the coefficients. Any candidate who has obtained the required average, and has passed as well in voluntary subjects, takes precedence of those who have obtained the same marks in obligatory subjects only.

No repetition of the examinations is ever allowed.

The decision as to the admission of a candidate rests in every case with the Minister of Marine.

A certain number of non-commissioned officers are attached to the school as assistant instructors in professional subjects. They are divided equally amongst the classes and courses, and attend all military and naval exercises.

The students are divided for study into five classes, the first

class comprising all the latest admissions to the Academy. Each class constitutes a squadron, and all the squadrons together a brigade of students.

As far as the exercises are concerned, the students are classified as follows:—

a. "Brigadiere."
b. Student "Graduato."
c. Simple student.

And for studies as—

a. Chief of the class—Capo Classe.
b. Second of the class—Sotto-Capo Classe.
c. Simple student.

The "Brigadieri" and the Students "Graduati" are appointed by the Council of Discipline from amongst students in the 5th class who, in addition to having distinguished themselves by their conduct and progress, possess authority and a military presence. Their nomination takes place at the commencement of the scholastic year, and they retain their appointment until the end of their term, unless deprived of it for misconduct. They have no direct disciplinary authority over the other students; but by their conduct and military bearing set them a good example. They must strive to maintain the harmony and *camaraderie* of the whole establishment. In the organization of squadrons into brigade they discharge the duties of sergeants and corporals, and as such bear on the left arm a distinctive badge, established by the Commandant.

At the commencement of each year the Council of Discipline nominates the Capo and the Sotto-Capo of each class, in accordance with the classification at the end of the last examination, excluding those whose conduct has not been satisfactory. In any case, in order to be appointed Capo or Sotto-Capo, a student must be amongst the first five of his class, and he may be deprived of his appointment during the term for misconduct or if he shows himself unworthy of such distinction.

As soon as they complete their seventeenth year the students may enrol themselves voluntarily. Such enrolment is authorized by the Minister of Marine, after it has been laid before him by the Commandant of the Academy, together with the approval of the parent or guardian, duly authenticated. These enrolled students, in addition to being, like the others, subject to the interior regulations of the Academy, are under the Military Code and Discipline Act.

Punishments.—The following are the punishments which may be inflicted in the Academy:—

1. Bad marks.
2. Punishment drill during hours of recreation from 1 to 5 days.
3. Punishment table from 1 to 3 days.
4. Stoppage of leave from 1 to 4 weeks.
5. Simple imprisonment from 1 to 10 days.
6. Close imprisonment from 1 to 10 days.

7. Arrest during the vacations preceding or following the cruise.
8. Loss of marks of distinction.
9. Severe reprimand.
10. Detention in a military prison from 1 to 3 months.
11. Enrolment into the "Corpo Reale Equipaggi" if the student is voluntarily enrolled, or expulsion if the student is not enrolled.

All the punishments from 1 to 9 must be inflicted by the Commandant. Only in the case of immediate and pressing necessity may any superior inflict No. 2, or an Officer order simple imprisonment, and even then a report must be immediately made to the Commandant, who fixes the length or manner of punishment. Nos. 10 and 11 are inflicted only by the Ministry of Marine on the recommendation of the Council of Discipline.

All punishments, except only Nos. 1, 2, 3, and 4, are entered in the culprits' reports. Bad marks are awarded for minor offences, such as neglect or slight acts of misbehaviour, want of attention or application during studies or lectures, and failure in obtaining marks for questions set in the classes; and their effect is to annul good marks previously obtained, or to subject the student to one of the punishments Nos. 3, 4, 5, and 6, according to the laws set by the Commandant.

No. 2 is inflicted for slight misconduct and inattention to orders, and may be accompanied with bad marks.

The punishment table is imposed specially for inattention in class and neglect of studies, and the effect is that the students so punished take their meals at a separate table, and are deprived of one of the courses and wine and fruit at breakfast and dinner.

Stoppage of leave is inflicted for breaches of discipline which do not require immediate repression, or for habitual neglect. It may be awarded in conjunction with any other punishment, or on account of repeated punishment during the preceding week, as may be laid down in the rules published by the Commandant.

Simple imprisonment is awarded in cases of serious breaches of discipline, and habitual negligence in studies.

Any student sent out of class must consider himself punished with simple imprisonment; on the award of the punishment, the student is locked in in a room kept for the purpose, and does not leave it except to attend lectures and exercises; he is also placed on prison diet of bread, broth, and meat.

On board ship the punishment is carried out between two of the guns.

Close imprisonment is awarded in cases of more serious breaches of discipline, and where the culprit shows himself indifferent to punishment. This is carried out in a room specially constructed, which the student is not allowed to leave; he does not attend lectures, and is placed on a ration of bread and broth only. On board ship this is carried out in any place that the Commandant may appoint, sanitary exigencies being taken into account. Prisoners

are deprived of their bedding, and sleep on a guard table furnished with one blanket; during exceptionally cold weather in winter, extra covering may be supplied them.

Arrest during vacations is inflicted by the Commandant, on the advice of the Council of Discipline, for complete or partial failure to pass the yearly examination, and for serious breaches of discipline following upon close imprisonment.

A student punished with close imprisonment loses a good-conduct badge; if sent back at the yearly examination he loses all good-conduct badges.

The badges of "Capo" and "Sotto-Capo" of the class and of student "Graduato" are lost for breaches of discipline. A student in possession of a good-conduct badge for studies loses it if he is not placed amongst the first six in his class in the yearly examination.

Severe reprimand is inflicted on any student who proves himself indifferent to the above-mentioned punishments, in the presence of all the Officers and students of the Academy. This is always accompanied with the maximum amount of close imprisonment, and bears with it a threat of expulsion.

Detention in a military prison is awarded to students guilty of the gravest breaches of discipline, and specially to ringleaders in disturbances.

Enrolment to complete the term of service in the "Corpo Reale Equipaggi" is carried out in the case of :—

1. A student who has proved himself indifferent to all other punishments;

2. A student guilty of the gravest breaches of discipline;

3. A student sent back a second time at the yearly examination; but this punishment is inflicted only on voluntarily enrolled students.

Rewards and Distinctions.—1. Marks of merit are awarded to students for special application in study, at the military and naval exercises, and for good conduct, and carry with them rewards established by laws published by the Commandant. Marks of merit for studies only cancel bad marks in studies, and those obtained for good conduct only bad marks for conduct.

2. A good-conduct badge is gained by a student who during six months has been awarded no higher punishment than No. 3, and who has obtained no less than 12/30ths of the marks in each subject at the monthly classifications during the same period. Any student who joins the Academy from a military college with good-conduct badges retains them on admission. This badge consists of the royal cipher embroidered in gold on black, with gold sceptre below. Within the cipher is embroidered in silver a horizontal bar for each good-conduct badge obtained by the student.

3. Badges for Studies.—A student who for two consecutive years has obtained a general average of not less than 16/30ths of the marks at the examinations for promotion, and is placed amongst the first ten in his class, obtains the Royal Badge of Merit for Studies, provided his conduct and professional qualifications admit of it. A

second and a third badge may be gained if the student continues to satisfy the above conditions.

This badge consists of the royal cipher embroidered in gold on red ground, with gold sceptre below. Within the cipher is embroidered in gold a horizontal bar for each badge obtained.

In the case of a student being in possession of both badges for good conduct and studies, the horizontal bars of gold are interlaced with those in silver within the royal cipher.

The student who during his last three years retains the first place in his class receives on his leaving the Academy, in addition to the yearly prizes, a sword of honour with his name and the date of the award engraved on the blade. The names and photographs of these distinguished students are preserved at the Academy, as a record of their achievements, and as an example to all others.

Leave of Absence.—Free leave is granted to students in the 4th and 5th classes on every Sunday, within the limits allowed by the time table. This is called ordinary leave, and the Commandant has power to either shorten or suspend it for service or sanitary reasons.

The students of the 1st, 2nd, and 3rd classes have no free leave of absence; they go out only accompanied by an Officer. Those who have living in Leghorn either parents, guardians, grandparents, uncles, brothers, or other relations may go out in their charge. These relations, in every case, must be of age, and must furnish to the Commandant a declaration from parents or guardians proving their relationship.

Organization of Studies.—The scholastic year begins on the 15th October, and ends on the 30th June of the following year, at the conclusion of the yearly examination.

Instruction is imparted in the various classes in the following subjects (the coefficient by which the marks obtained are multiplied to arrive at the general classification is appended to each subject):—

1st Class.

1. Elementary Algebra, 3.
2. Plane and Solid Geometry, 3.
3. Italian, 3.
4. Political History, 3.
5. Geography, 2.
6. French, 2.
7. Drawing, 1.
8. Professional Instruction and Exercises, 1.
9. Gymnastics, Fencing, &c.

2nd Class.

1. Algebra, 3.
2. Rectilineal and Spherical Trigonometry, 3.
3. Plain Navigation, 3.
4. Italian Literature, 2.
5. Political History, 2.

6. Geography, 2.
7. French, 2.
8. English or German, 2.
9. Drawing, 1.
10. Professional Instruction and Exercises, 1.
11. Gymnastics, Fencing, &c.

3rd Class.

1. Algebra, 3.
2. Analytical Geometry, 3.
3. Descriptive Geometry, 3.
4. Elementary Astronomy, 3.
5. Physics, Part I, 3.
6. Italian Literature, 3.
7. Political History, 2.
8. French, 2.
9. English or German, 2.
10. Artistic Drawing, 1.
11. Professional Instruction and Exercises, 2.
12. Gymnastics, Fencing, &c.

4th Class.

1. Infinitesimal Calculus, 3.
2. Nautical Astronomy, 3.
3. Physics, Part II, 3.
4. Italian Literature, 3.
5. Natural History, 3.
6. Political History, 2.
7. French, 2.
8. English or German, 2.
9. Artistic Drawing, 1.
10. Professional Instruction and Exercises, 3.
11. Gymnastics, Fencing, &c.

5th Class.

1. Mechanics, 3.
2. Astronomical Calculation, 3.
3. Artillery, 3.
4. Naval Construction, 3.
5. Steam Engines, 3.
6. Naval Manœuvres and Tactics, 3.
7. Hydrography and Topography, 3.
8. Submarine Mines, 3.
9. Chemistry, 3.
10. Conversational English or German, 3.
11. Professional Instruction and Exercises, 2.
12. Gymnastics, Fencing, &c.
13. Telegraphy, 3.

The Training Cruise.—At the end of the yearly examinations the students embark on the ships attached to the Academy for a four months' cruise. The Rear-Admiral in command of the Academy assumes chief command, and the staffs of the several ships are formed by the Officers of the Academy, together with a full complement of men, &c., and in addition those non-commissioned officers whom the Commandant thinks necessary as assistant instructors.

Time Table.

	Week Days.	Holy Days.
Reveillé	5.0—5.30	5.0 —5.30
Study	5.30—7.20	5.30—7.20
Arranging books and recreation	7.20—7.30	7.20—7.30
Breakfast	7.30—7.45	7.30—7.45
Medical inspection and recreation	7.45—8.10	7.45—8.10
Inspection	8.10—8.15	8.10—8.15
Lectures	8.15—11.15	—
Mass and religious instruction	—	8.15—9.0
Practical exercises	—	9.0 —11.15
Punishments—lunch	11.15—12.0	11.15—12.0
Relaxation	12.0 —12.30	12.0 —12.30
Study	12.30— 1.25	—
Lectures	1.25— 4.0	—
Arranging books and recreation	4.0 — 4.10	—
Exercises	4.10— 5.10	—
Change of clothes and inspection of the students with free leave and leave with parents, &c.	—	12.30—1.0
Leave of absence	—	1.0 —5.0
Study for students remaining in the academy	—	12.30—1.30
Change of clothes and inspection in the academy	—	1.30—2.0
Walking out (obligatory)	—	2.0 —5.0
Recreation	5.10— 5.20	
Change of clothes	—	5.0 —5.20
Dinner	5.20— 6.0	5.20—6.0
Recreation and relaxation	6.0 — 6.45	6.0 —6.45
Study	6.45— 8.45	6.45—8.45
Recreation	8.45— 9.0	8.45—9.0
Bed	9.0	9.0
Lights out	9.10	9.10

Other Schools.

School of Machinery.—Established at Venice for the instruction of youths intending to enter the profession of naval engineers.

The Staff of the school is composed as follows:—

A Captain or Post Captain as Commandant.

A Lieutenant as Company Officer.

Two Officers as assistants.

Four engineers as Officers of the watch and Instructors.

An administrative Officer in charge of accounts, &c.

A Medical Officer.

The Civil Staff consists of nine Professors and four Masters, and a certain number of servants, porters, cooks, &c.

There is also attached to the school a detachment of men of the Corpo Reale Equipaggi for military purposes. The instruction is theoretical and practical, and the subjects of instruction are divided into four classes, one for each year of attendance at the school.

The admission of the pupils takes place every year, and is open to Italian subjects who fulfil the necessary conditions, that is to say:—

1. Who have a constitution which fits them for the duties of the Service.

2. Who have completed fourteen years of age, and who are not more than eighteen years of age on the 10th July of the year of admission.

3. Who have passed through an apprenticeship as ironfounder, boiler maker, forger, or joiner.

4. Who are acquainted with simple arithmetic, Italian grammar, the rudiments of rectilineal drawing, and have a good hand-writing.

The candidates are examined orally in plain arithmetic and in writing as follows:—

1. In the solution of a problem in arithmetic proportionate to the standard fixed for the oral examination.

2. In Italian composition, to show that the candidate is acquainted with the orthography and the grammatical rules of the language, and that he possesses a good hand-writing.

3. In the graphic solution of an elementary problem in rectilineal drawing, and in copying a very simple design of a piece of machinery.

The practical examination consists in the execution, in the presence of the Board of Examination, of some work in one of the workshops of the Royal Arsenal.

The following coefficients are assigned to the various subjects of examination:—

Arithmetic, 3; Italian, 3; Drawing, 1; and Practical Work, 1.

The students if found fit for the Service are enrolled for a period of six years if they are seventeen years of age or over on leaving the school, or for six years from the age of seventeen if below that age. They do not pay anything during their sojourn at the school, but are rated as 3rd class seamen on land. On completing the course, and passing the final examination, they are nominated 3rd class engineers (quartermasters) in the Corpo Reale Equipaggi, and embark on an armed cruiser for a probationary period of not less than two months or more than six, in order to test their suitability for the sea. If approved at the end of this cruise they are confirmed in their appointment; but if not approved, they undergo a second test of six months at most; and if again not approved, special steps are taken with regard to them as may be deemed best from their talents, the circumstances of the case, or the needs of the Service.

Higher Course for Student Commissaries.—This takes place annually near the three Maritime Departments, with the object of preparing young commissariat Officers for the naval administrative service. The instructor is a superior administrative Officer.

Artillery School.—Established on a ship in the harbour of Spezia, for the training of gunners and master gunners.

Torpedo School.—Also at Spezia, for the instruction of torpedo detachments.

School of Telegraphy.—Also at Spezia.

Training School on board ship, to prepare boys for the sea. Boys are admitted between sixteen and seventeen; the course lasts one year, at the end of which the boys are enrolled as 3rd class seamen in the Corpo Reale Equipaggi.

School for Apprentices in the arsenals, to furnish to the Artillery and Torpedo School-ships a certain number of students instructed in mechanics, and to train youths as military artificers. The course is divided into four classes.

The Higher Naval School at Genoa is maintained by the province, the Commune, and the Chamber of Commerce with the sanction of the State, and its object is to train naval engineers and mechanics; Instructors in nautical astronomy, navigation, hydrography, physical geography, meteorology, naval construction, and machines and steam power; hydrographical engineers; and to complete the theoretical and practical instruction of naval machinists.

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A combined Electric Belt and Suspender (Mr. Harness' latest invention). It acts directly upon the vital organs, by imperceptibly generating mild, invigorating electric currents, which pass from the spinal cord direct to the scrotum. It cannot fail to restore impaired vigour, and speedily renew that vital energy the loss of which is the first symptom of decay. For varicocele and kindred troubles it is invaluable. No man should be without one of these perfect health appliances. Call and see them scientifically tested, or write at once for particulars to Mr. C. B. Harness, President, Electropathic Institute, 52, Oxford-street, London, W. All communications are treated as strictly private and confidential.

THE PROGRESS OF MEDICAL ELECTRICITY.

(Reprinted from a leading Belgian daily newspaper.)

No stranger visiting London will regret to have sacrificed a few moments in examining the imposing building of 52, Oxford street (corner of Rathbone-place), the seat of a celebrated company, known under the name of the Medical Battery Company (Limited), the President of which is Mr. C. B. Harness, who, struck by the curative qualities of electricity, has persevered for many years past in adopting and perfecting the most ingenious methods and inventions. With an ever-increasing success he has introduced his electropathic treatment for almost all the diseases which afflict humanity. He has invented and brought to a high degree of perfection the Electropathic Belt, which is composed of a system of batteries actuated by moisture from the skin. These batteries supply the organism with a continuous and mild current of electricity acting imperceptibly with a great power on the whole of the system. Nervous diseases and general debility, rheumatism, gout, diseases of the liver and kidneys, &c., they have always ameliorated, and often effected the complete recovery of the patient, as has been proved by the numerous letters and testimonials, recommendations of eminent physicians, &c., which the Company are constantly receiving.

Besides these Belts of various electric power of all sizes and forms, the extensive rooms of the institution contain all the electric appliances, from the simplest to the most complicated, that science has produced, to act by powerful or mild currents, according to the requirements of the special diseases submitted to them for treatment. Other rooms are fitted with electric baths, or devoted to massage by hand or machinery, assisted by electric currents; and last, some rooms are set apart for Swedish mechanical exercise for the development of the muscles, the correcting of the defects of the limbs, and the general strengthening of the system. In short, this establishment is the most perfect of its kind existing, and the physicians, electricians, and other officers in attendance can be consulted gratuitously, either personally or by correspondence. The work is admirably conducted by employees and nurses of both sexes. Those who visit the Company's Electropathic and Zander Institute will come out of it with the conviction that electricity is not only the least dangerous but at the same time the most powerful curative agent known. Consultation and advice can be obtained gratuitously, either by personal application or letter. All communications are regarded as strictly private and confidential, and should be addressed to Mr. C. B. Harness, President of the Medical Battery Company (Limited), 52, Oxford-street, W.

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EXTRACT FROM THE BYE-LAWS.

Section II.—Composition.

1. Princes of the Blood Royal; Lords Lieutenant of Counties; Governors of Colonies and Dependencies; Officers of the Army, Navy, Marines, Hon. Majesty's East Indian Military and Naval Forces, Militia, Yeomanry, Royal Naval Reserve, and Volunteer Corps shall be entitled to become Members, *without ballot*, on payment of the Entrance Fee and Annual Subscription.

N.B. Any Officer coming within the above definition, who may wish to become a Member of the Institution, can do so by copying one of the subjoined Forms, and delivering it to the Secretary:—

FORM FOR BECOMING AN ANNUAL SUBSCRIBER.

_____ 18

It is my desire to become a Member of the Royal United Service Institution; and I hereby request and authorise my Agents [or Bankers], Messrs. _____, to pay my Entrance Fee (£1) and Annual Subscription (£1) now, and as it becomes due on the 1st of January in each year, to the Secretary of the Institution.

_____ Signature.

_____ Qualification for Membership.

FORM FOR BECOMING A LIFE SUBSCRIBER.

It is my desire to become a Life Member of the Royal United Service Institution; and I hereby authorise my Agents [or Bankers], Messrs. _____ to pay my Entrance Fee (£1) and Life Subscription (£9) to the Secretary of the Institution.

_____ Signature.

_____ Qualification for Membership.

2. Ex-Governors of Colonies and Dependencies, Retired Officers, Deputy Lieutenants of Counties, Civil Functionaries who are or have been attached to the Naval and Military Departments, the Master, Deputy Master, and Elder Brethren of the Trinity House, and Army and Navy Agents, shall be eligible to become Members by *Ballot*.

3. Gentlemen above the age of fifteen, whose names are on the list of the Commander-in-Chief for Commissions in the Army, or who are probationary for offices connected with the Naval and Military Establishments, shall be *admissible*, by *Ballot*, to become PROVISIONAL MEMBERS from year to year, on payment of the Annual Subscription; and after they obtain their appointments, they may become ordinary Members on payment of the Entrance Fee.

N.B. Members admissible by Ballot must be proposed and seconded by two Members of the Institution, and their names will be submitted to the Council for election. Ballot papers may be obtained at the Institution.

Form of Request.

I give and bequeath unto THE ROYAL UNITED SERVICE INSTITUTION, *situated in Whitehall Yard, London, the sum of*

to be applied in and towards carrying on the designs of the said Institution, such Legacy to be paid out of such part of my personal Estate not specifically bequeathed as the law permits to be appropriated by Will to Charitable Purposes.

CAPTAIN JAMES,

5, Lexham Gardens, Cromwell Road, London, W.

(having by mutual consent dissolved partnership with Colonel Lynch), continues as heretofore to devote his whole time to PREPARE PUPILS for ALL ARMY EXAMINATIONS, and the UNIVERSITIES.

N.B.—The whole Staff of Tutors, whose assistance has been so valuable in conducing to the great success of the Establishment, remain with Captain James.

SUCCESSES IN 1889-90-91.

INDIAN CIVIL SERVICE.

ELEVEN Passed. Places taken include 2nd, 6th, 7th, 8th, 9th, &c., on the various lists. Places taken in the various subjects comprise—First, 3rd, 4th, 5th, 6th, and 7th Political Economy; First, 4th Logic; 2nd, 3rd, 4th Mechanical Philosophy; 3rd French; 4th German; 5th Latin; 10th Mathematics; 8th, 10th (twice) Italian; 3rd Composition; 4th, 6th (twice), 10th History; 2nd, 3rd, 4th, 5th, 6th, 10th Literature.

WOOLWICH.

TWENTY-ONE Passed, including 6th and 7th on the List. Places taken in the various subjects comprise—First mathematics; 5th Latin; 6th, 7th, and 8th German; 3rd Greek; 2nd and 3rd History; First Chemistry; First Geology; 6th and 8th Geometrical Drawing.

SANDHURST.

ONE HUNDRED and SEVEN Passed, including two 1sts, four 2nds, three 3rds, &c., on the various lists. Places taken in the different subjects include—2nd and 6th Mathematics; 1st (twice) and 4th (twice) in Latin; 1st, 2nd, and 4th French; 3rd, 5th, and 6th Greek; 1st (highest marks under present regulations), 4th, 6th History; 1st, 3rd (twice), 4th, and 5th Chemistry; 1st (thrice) and 2nd Geology; 1st (twice) in Freehand; and 1st and 2nd (twice) in Geometrical Drawing.

MILITIA LITERARY.

SIXTY-FOUR Passed. Places taken include 1st (twice), 2nd, 3rd, 4th, &c. Places taken in the various subjects are—2nd (thrice) in Mathematics; 1st (twice) and 3rd Latin; 2nd and 3rd (twice) French; 3rd (twice), 4th, 5th, and 6th German; 1st, 2nd, and 5th Greek; 3rd, 4th (twice), 5th (twice) History; 1st Chemistry; 1st (twice), 2nd (twice), 4th, and 5th (twice) Geology; 1st, 2nd, and 4th Freehand; 1st, 2nd, 3rd, and 4th (twice) Geometrical Drawing. In April, 1892, ALL sent up passed. Places taken were 5th, 35th, 46th, 48th, and 54th.

N.B.—These numbers do not comprise those who qualified at the Sandhurst Examination.

MILITIA MILITARY COMPETITIVE.

ONE HUNDRED and FORTY Passed. Places taken include SEVEN 1sts and three 2nds on the various lists. Places taken in Topography, Law, Tactics, and Fortification include four 1sts, six 2nds, six 3rds, four 4ths, &c.

In March, 1892, of the Sixty-two Successful Candidates SEVENTEEN passed from Captain James.

Place.	Name.	Marks.	Place.	Name.	Marks.
First ...	F. Godfrey Fausset ...	1,935	*17th ...	R. H. Hunter Weston ...	1,850
6th ...	W. C. C. Ash ...	1,894	20th ...	E. C. F. Wodehouse ...	1,838
7th ...	C. B. Prowse ...	1,887	24th ...	W. Marriott Dodington	1,806
8th ...	J. C. Mack ...	1,886	27th ...	R. G. T. Bright ...	1,795
9th ...	C. D. Christopher ... A. R. C. Savile ...	1,881	29th ...	T. K. Gaskell ...	1,792
12th ...	A. J. Lean ...	1,876	*42nd ...	H. G. Scott Harden ...	1,761
18th ...	D. J. Propert ...	1,858		C. H. Pringle ...	1,709
	CAVALRY.			ARTILLERY.	
*3th ...	M. M. Litkie ...	1,865	4th ...	E. W. Holman ...	1,843

* Prepared at the Country Branch.

In addition to the London Classes, a Country Branch has been opened for the Militia Competitive at Camberley, under the personal superintendence of Lieut.-Col. W. S. Fox, late R.A. (Honours) Staff College, assisted by Lieut.-Colonel Cooper King, late R.M.A., 1st Staff College.

The CIVIL STAFF embraces Thirty-three Gentlemen, of whom Twenty are University Graduates in high honours. The Military Staff includes Twelve Officers, of whom Five are Staff College Graduates in honours. The total number of Forty-five is far larger than will be found at any other establishment in England, and is sufficient to give that individual instruction to the pupils to which the above remarkable successes are due, and which for many years past have exceeded the results of any other tutor or school.

Captain James can be seen daily at twelve noon, except Saturday.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.